WHEN BEVERLY J. TEPPER LECTURES, SHE OFTEN LEAVES HER audience with their tongues hanging out. Literally. As part of a talk on taste sensitivity, she passes out little circles of filter paper embedded with what is, to some people, a bitter-tasting compound with the unappetizing name of 6-n-propylthiouracil. She can tell immediately who in the audience is genetically programmed to taste it. “It is absolutely striking,” she said. “You can see it on people’s faces.” Those who are sensitive to the compound usually grimace like a baby tasting its first Brussels sprouts. The non-tasters look curiously around the room, wondering what the fuss is about because “it literally tastes like a piece of paper to them.” It’s more than a party trick. This little test may provide genetic clues as to why some people like vegetables and others don’t, why some can eschew high-fat foods and others can’t, and why some people stay thin while others (many others) gain weight. Tepper, N82, N86, a food science professor at Rutgers University, has been studying taste sensitivity for almost two decades. As an academic who often works closely with the food industry, she is combining food sensory science with nutrition science and psychology to better understand the links between taste, diet and health.
er interest in taste genetics began around 1994 when she was investigating why some people enjoy high-fat foods more than others do. She asked test subjects to rate foods with different levels of fat, and then tried to cross their reactions with different variables, such as their age, sex, attitudes toward nutrition, what they grew up eating and whether they could control their food urges. "But nothing was coming out of that [research] that was really very interesting," she said. "It's the kind of thing that food companies tear their hair out trying to understand: Is there something about people's backgrounds that pushes them in one direction or the other about what they prefer?"

NON-TASTERS AND SUPER-TASTERS

Then she learned about a colleague's study that found that people who were really sensitive to that bitter 6-n-propylthiouracil (or PROP, for the tongue-tied) also, for some reason, gave higher creaminess ratings to dairy products than those who could not taste PROP. "Maybe that's the key," Tepper recalled thinking about her own research. "Maybe the variability is genetic. It's biological. It's not just something out in the air."

PROP is nothing new. PROP sensitivity had been known as a genetic trait since it was discovered in the 1930s. People with the TAS2R38 genotype have receptors on their tongues that recognize the acrid substance.

Based on the dairy study, Tepper thought that the PROP test could tell her more than how well people could tolerate bitterness. She started by dividing test subjects into PROP non-tasters, medium tasters and particularly sensitive "super-tasters." (Statistically, about 25 percent of Caucasians are non-tasters; 50 percent are medium tasters, and 25 percent are super-tasters.) She then gave them high- and low-fat versions of salad dressings to taste. As predicted, the non-tasters liked the high-fat dressings better.

Subsequent work by Tepper and others has pointed to a host of taste tendencies that separate tasters from non-tasters.

"We recognized that PROP tasters not only taste the bitterness of PROP and the bitterness of other compounds more, but they perceive sweetness more; they perceive the textural aspects of dairy products more; they perceive hotness—like chili pepper—more," Tepper said. "It's a whole range of sensory characteristics that they seem to be more sensitive to."

How is one bitter receptor on the tongue responsible for all these differences? One theory is that people who are tasters, and in particular, super-tasters, seem to have more taste buds. And people who have more taste buds, it follows, may experience most taste sensations more intensely.

Perhaps because of this, super-tasters also seem to pick up on food nuances. When Tepper asked study subjects to describe a range of dairy products they tasted, the super-tasters used lots of adjectives—creamy, thick, rich, buttery, sticky, syrupy and milky. The non-tasters used just a handful of words to describe what they ate. "They perceive something different," Tepper explained, "and they clearly know what they like, but they have difficulty describing it."
WEIGHING IN
All of which may be useful for predicting who will grow up to be a food critic. Tepper, however, is looking for a connection that could have larger public health implications: How does PROP taster status affect weight?

Two years ago, Tepper found that women in their 40s who were super-tasters were 20 percent thinner than non-tasters. The super-tasters appeared to eat less overall, be it bitter vegetables or fatty foods. The super-tasters had a body-mass index of 23.5; the medium tasters had an average of 26.6, and the non-tasters nearly 30. (A BMI of 30 or above is considered obese.) So far, she has only seen body-weight correlations to PROP status in women, not men.

But before you run out to have your PROP status tested, you should know that there are plenty of exceptions to these rules. Tepper is herself a super-taster. (“That little disk is so bitter to me, it blows the back of my head off,” she explained.) And yet, she likes all the foods she theoretically should hate. “It took me a number of years to develop a taste for them, but I like hot food; I like briny olives; I like anchovies; I like broccoli and Brussels sprouts,” she admitted. “After a while I thought, ‘I don’t even support my own hypothesis, so how is this going to work?’ It’s rather obvious: It’s not just taste genetics that’s influencing people’s behavior and food preferences. There are so many other factors. And we can’t just forget about all of them.”

DARING DINERS
One significant factor is food adventurousness, or a willingness to try unfamiliar foods.

“We decided to add just a single question to our surveys: How often do you try new foods?” They found that super-tasters who are not food adventurous are the ones who hate everything. As a super-taster who is also food adventurous, Tepper’s food preferences make perfect sense.

Another trump card is a person’s ability to fight food urges, called “restrained eating.” People’s self-control, particularly if they are concerned about nutrition or their weight, seems to override taster status, so that statistically, it has no effect on body-mass index. So this one gene does not control weight—or definitively determine what foods you like. Nor does it mean that super-taster children are destined for a vegetable-free life. Tepper recently looked at a group of preschoolers to understand when these genetic differences appear. (The results appeared this July in the American Journal of Clinical Nutrition.) She offered the kids carrots and red pepper along with the more bitter cucumbers, raw broccoli and black olives (which, while not technically vegetables, are viewed that way by children).

The children showed clear signs of their PROP status and food preferences at this early age. The non-tasters spontaneously ate almost a serving of vegetables, including more of the bitter ones. But the taster kids were no slouches, eating almost a half-serving of vegetables of their choosing.

“It is possible to get vegetables into kids if you pay some attention to their genetic predispositions. What’s ultimately valuable is what someone selects or doesn’t select when they are given a variety of choices,” Tepper said.

One question she has is whether mothers, who make most of the menu decisions at home, are offering their children vegetables that they may not like themselves and giving their children an opportunity to develop a preference for them.

Tepper, who grew up in Boston and studied biology at Northeastern University, was a member of the first nutrition school class at Tufts. Looking back, she is glad that she and her classmates were required to study not only basic nutritional biochemistry, but also the impact of nutrition on people, including those in the developing world. “You really understood the interdisciplinary nature of nutrition, and I find that is a bit lacking in some programs,” she said.

After graduating with her Ph.D. in 1986, she completed a postdoctoral fellowship at the Philadelphia-based Monell Chemical Senses Center, a research institute focused on taste and smell research. Her interest in sensory evaluation was born. When a position came up at Rutgers for a sensory scientist in 1989, she took it.

As director of Rutgers’ Sensory Evaluation Laboratory, Tepper often collaborates with food companies. “When I work with industry, usually there is something applied in it that they are interested in and something
basic research-oriented that I'm interested in. It's really a marriage of the two." She has worked with the Linguagen Corp., a biotechnology company that received a patent for the first molecular compound that blocks bitter tastes in foods and drugs. In her lab—which has a kitchen and 11 tasting booths equipped with computers where test participants record their reactions to foods—she tested the bitter blocker in combination with black coffee, dark chocolate, white grapefruit juice and tonic water. The blocker helped blunt the bitterness of the coffee, but nothing else.

DIETS FOR DIABETICS
Other tests are purely for scientific elucidation. Tepper has been interested in diabetes research since her graduate school days. One of her first studies was to confirm the long-held medical belief that people with type 2 diabetes have an increased desire for sweets.

More recently, she has been focusing on women with gestational diabetes. Her studies so far have found that pregnant women with diabetic symptoms tend to like sweetened drinks, such as strawberry milk, and report that they consume more sweet foods in their diet. Tepper is interested in how pregnant women's increased desire for sweet foods may influence their dietary compliance. Women who are diagnosed with gestational diabetes usually receive the same dietary recommendations as those given for type 2 diabetics, but they do not always follow those recommendations. In the long run, she hopes this research will help focus nutritional recommendations for women with gestational diabetes and for diabetics in general.

Most of Tepper's students go on to work in the food industry. "A lot of our students have backgrounds in biology or microbiology or chemistry, and often they are students who like science, but they can't see the application. They come into food science, and they see chemical and biological principles being illustrated in something they know very well, which is food, and all of a sudden, the spark happens, and they get very excited about it."

Of the 22 full-time faculty who work in the food science department at Rutgers, just two have backgrounds in nutrition. Most food scientists are concerned with the chemical and biological aspects of foods rather than the organisms that eat them. They leave that to the nutritionists.

PARTNERING NUTRITION AND SCIENCE
Tepper says her nutrition education gives her a special vantage point, one that convinces her there should be more collaboration between nutrition and food science departments. "I think they should be closer," she said. "If you have someone who understands the basic biology of a fat cell, and then you have a food scientist who understands the physical and biological dimensions of putting fat into a food product, I see a lot of strength there."

Tepper and other PROP researchers are looking at several ways that this one genetic proclivity may affect public health. At least one study has found that heavy smokers are significantly more likely to be non-tasters than tasters, who appear more sensitive to the irritation of smoke and the bitterness of nicotine. Similarly, tasters perceive more bitterness and irritation from ethyl alcohol, and research has found that tasters consume fewer alcoholic beverages per year than non-tasters. Tepper stresses that more work needs to be done in both areas, and that if there is a PROP connection, it would only be a risk factor, not a genetic mandate.

"My view is this is just another indicator as to whether a person is going to find alcohol acceptable or not," she said. "But to conclude that this determines whether it makes them an alcoholic or not is kind of far-fetched."

In the future, Tepper believes PROP research will be especially useful in the fight against obesity. Although there have been hundreds of studies looking at PROP status over the decades, only recently has it been recognized for its potential influences on eating behavior and body weight.

To epidemiologists who study obesity, PROP status may be the new kid on the block. But Tepper thinks it will win them over. "We have identified a lot of obesity genes, but many of those genes are involved in very rare forms of human obesity," Tepper said. "Whereas here's a phenotype that's really easy to measure, that seems to be related to body weight."

She is already collaborating with one scientist who is studying a genetically isolated population in a village in southern Italy, which, because the villagers have similar genetic backgrounds and diets, should provide a clearer understanding of PROP status' relationship to diet and disease outcomes.

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