

FAKE FOOD, REAL RISK

Melted, pounded, extruded: Why many ultra-processed foods are unhealthy

Industrial processing changes the structure of food. Experts say it can affect how much you eat and absorb, your weight and risk for chronic disease.

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Would you eat food that's been predigested?

Experts say that's what we're doing when we consume many popular packaged foods — those breads, cereals, snack chips and frozen meals that have been refined, pounded, heated, melted, shaped, extruded and packed with additives.

A growing body of research suggests that the extent of industrial processing that your food undergoes can alter its effects on your body, determining its impact on your appetite, hormones, weight gain, and likelihood of developing obesity and chronic diseases.

This extreme processing creates foods that are so easily absorbed by the body that they're essentially predigested. Many foods also are engineered to overcome our satiety mechanisms, which drives us to overeat and gain weight, experts say.

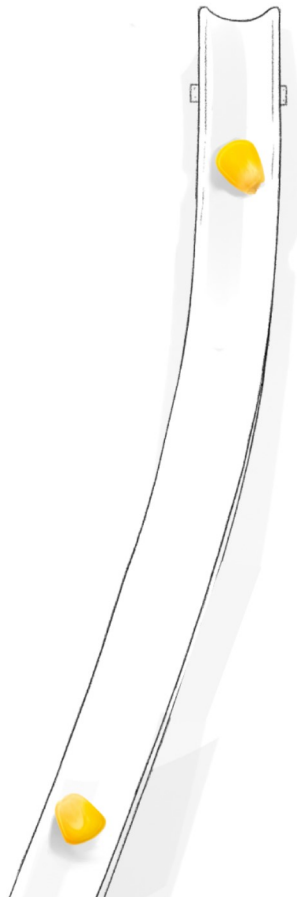
In recent years, scientists have adopted a new name for foods that are intensely manipulated by food manufacturers: ultra-processed.

The journey of two corn kernels

Almost all foods undergo some level of processing. Even fresh vegetables like [baby carrots](#) are washed, peeled, cut and packed by machines at processing facilities before they arrive at grocery stores. But ultra-processed foods are transformed from simple ingredients into industrial products with unusual combinations of flavors, additives and textures, many of which are not found in nature.

First, corn kernels are removed from the cob and cleaned.

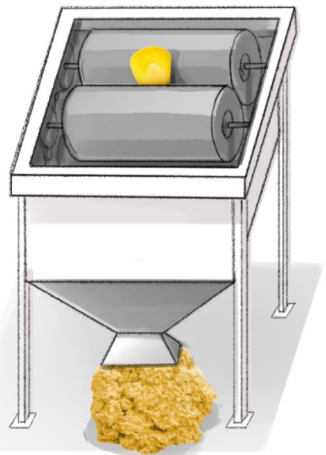
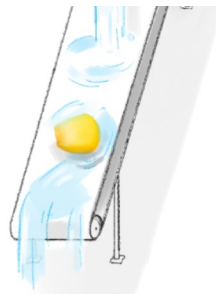
**Processed
canned corn**



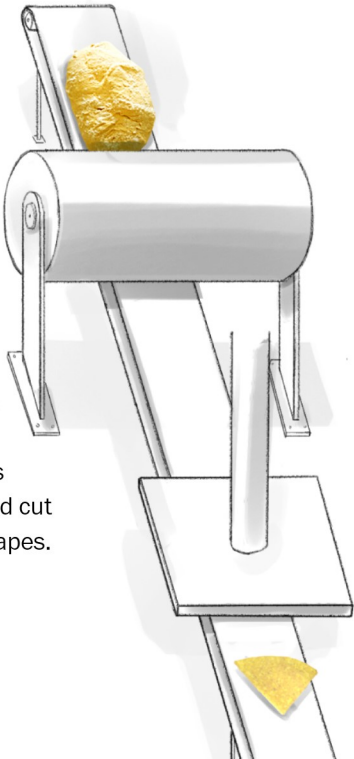
**Ultra-processed
snack chip**



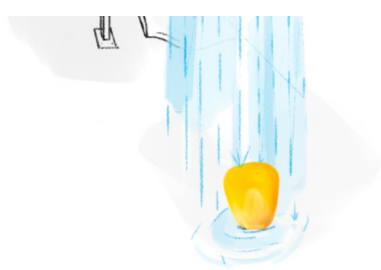
The corn is cooked and soaked to absorb water.



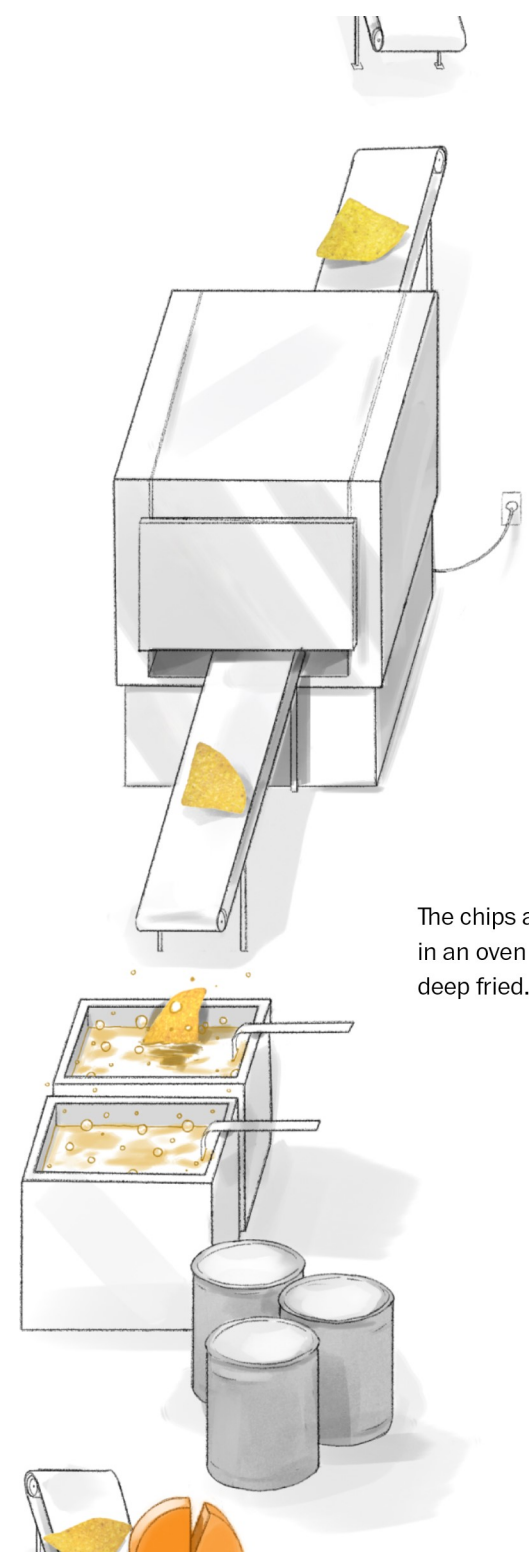
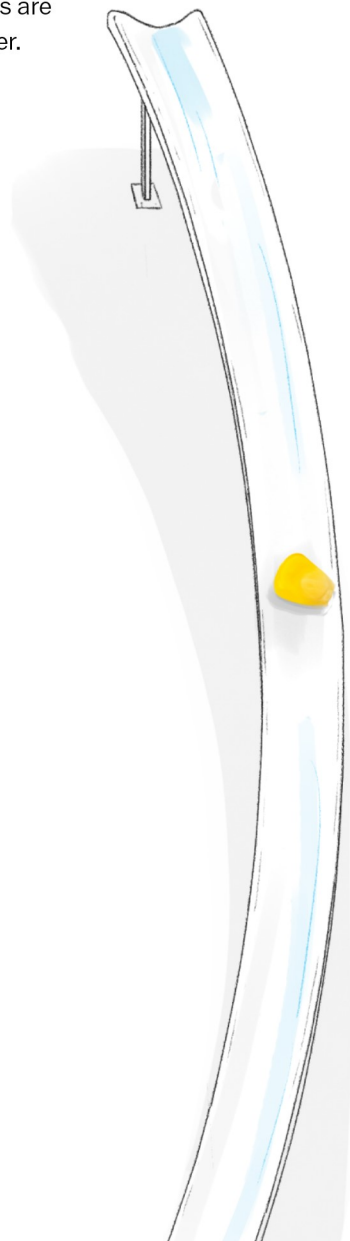
Next the corn is pulverized into a dough. Then it's fed into an extrusion machine and molded into sheets.



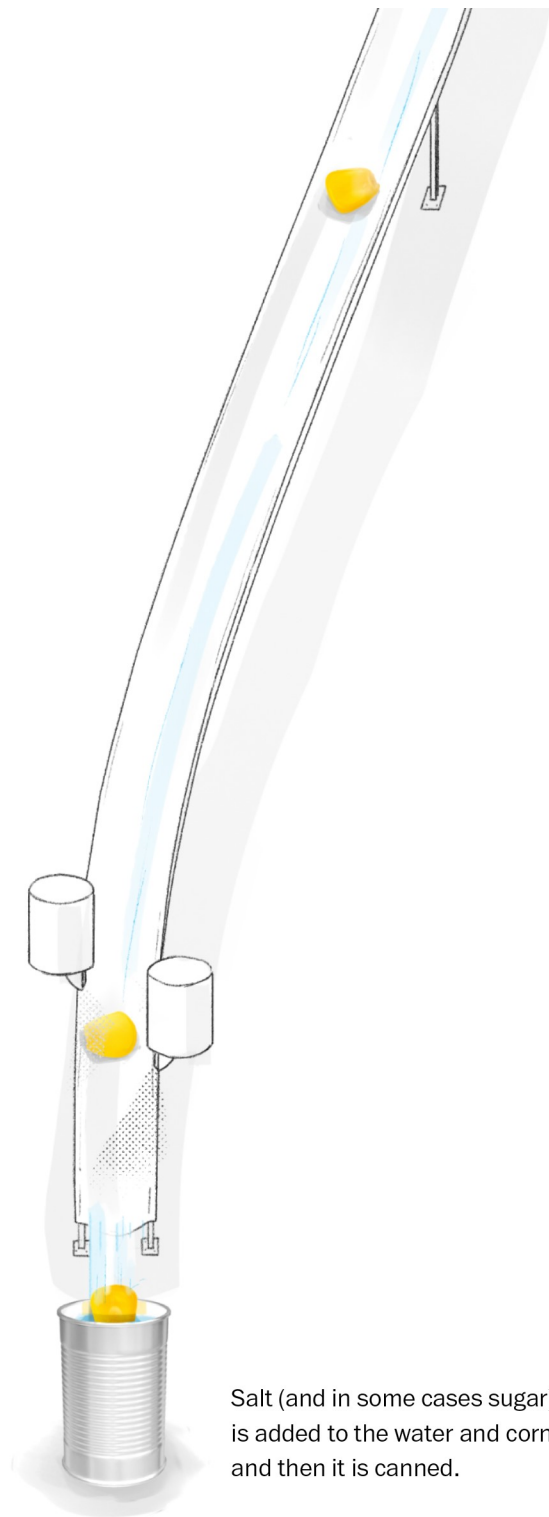
The dough is flattened and cut into chip shapes.



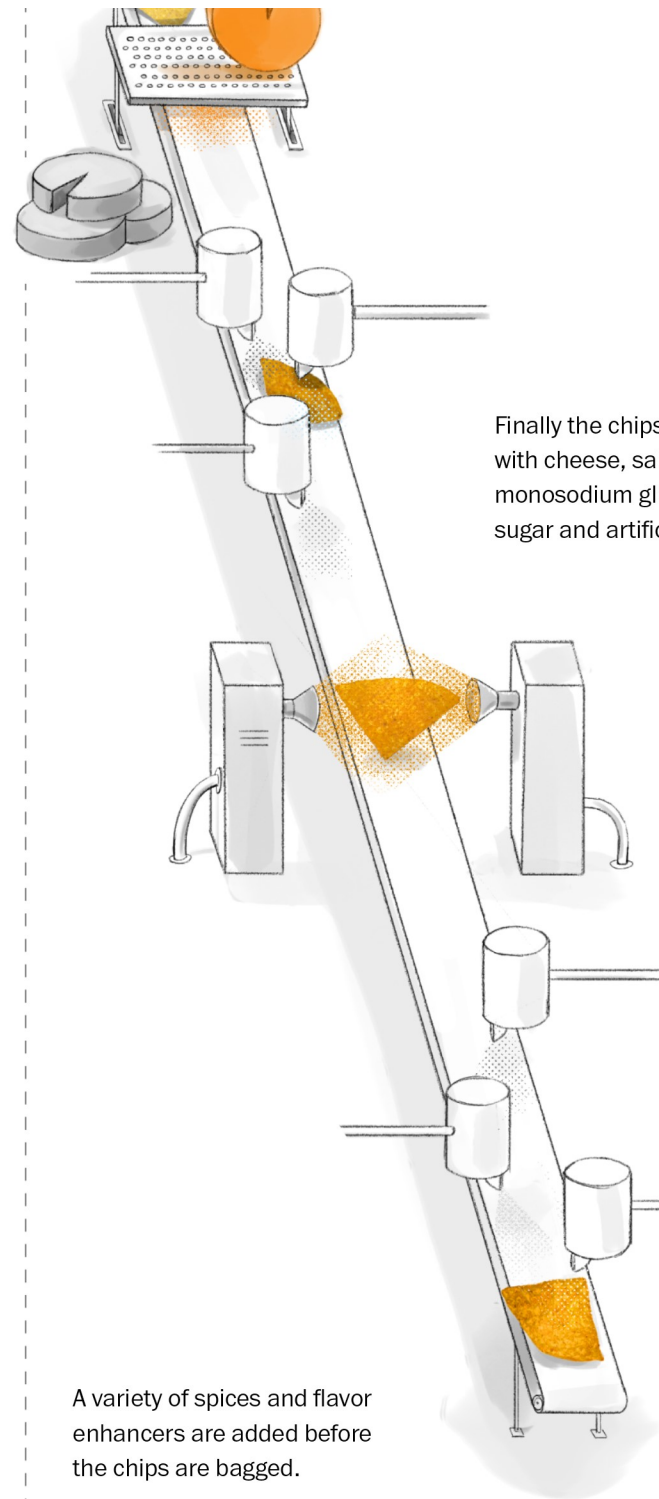
The corn kernels are mixed with water.



The chips are baked in an oven and then deep fried.

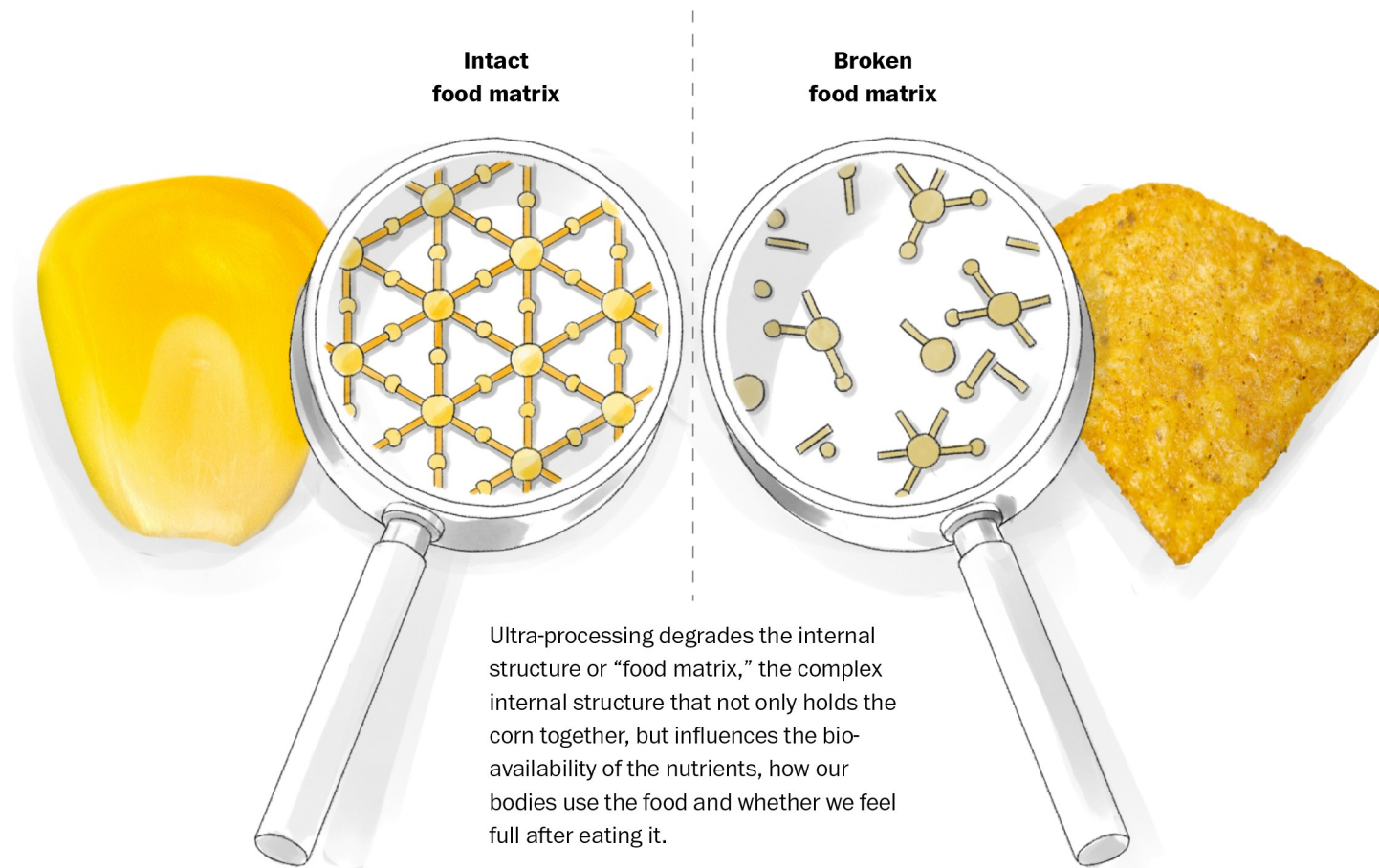


Salt (and in some cases sugar) is added to the water and corn, and then it is canned.



Finally the chips are coated with cheese, salt, monosodium glutamate, sugar and artificial colors.

A variety of spices and flavor enhancers are added before the chips are bagged.



Ultra-processing degrades the internal structure or “food matrix,” the complex internal structure that not only holds the corn together, but influences the bio-availability of the nutrients, how our bodies use the food and whether we feel full after eating it.

Across the globe, governments are embracing the idea that ultra-processed foods are a big contributor to poor health. Many countries have issued dietary guidelines encouraging people to include more unprocessed foods in their diet, and some, like Brazil, Belgium, Israel and Uruguay, have published dietary guidelines explicitly urging people not to eat ultra-processed foods.

In the United States, where ultra-processed foods make up 58 percent of the calories Americans consume, government experts are examining the link between ultra-processed foods and obesity, and their findings could influence the government’s influential Dietary Guidelines for Americans.

But supporters of the packaged food industry say processed foods are an essential part of the food supply.

“Processed foods in general help create a more affordable, available, and accessible food environment,” said Bryan Hitchcock, chief science and technology officer for the Institute of Food Technologists, in an email. “Processing technologies, particularly at the industrial scale, add value, safety and nutrition while reducing costs and food loss and waste.”

How ‘extrusion cooking’ alters your food

Many ultra-processed foods start with fiber-rich grains like wheat, rice, oats and corn. Food companies use high-speed steel rollers to mill these grains into flour or small particles. In some cases, the grains are refined, meaning their fiber and nutrient-rich components, the bran and germ, are removed.

These refined starches are often used to thicken and improve the “mouthfeel” of processed foods like puddings, sauces, salad dressings, canned soups, stews and baked goods. But they’re also used to make a variety of other ultra-processed foods through a manufacturing technique called extrusion cooking.

Cooking extruders have spawned a multibillion-dollar industry: They are widely used by food companies to mass produce many of the starchy and sugary packaged foods that line grocery store shelves.

Cooking extruders contain rotating screws inside a large steel barrel. Flour, water and other ingredients are poured into one side of the machine as the rotating screws blend and force the mixture through the barrel.

While the process can vary, the machine typically twists and heats the mixture, generating intense pressures, shear forces and temperatures that melt the mixture. This process disrupts the food matrix of the starch: It breaks open the rigid cell walls inside the starch and destroys its microscopic granules, which contain long chains of glucose, a type of sugar.

Eventually, the “melt,” as the mixture inside the cooking extruder is called, is forced out of the machine through a small hole called a die. As it exits, the melt encounters a drop in atmospheric pressure that causes it to expand.

The final product, called the “extrudate,” can be shaped into an endless variety of ultra-processed foods: breakfast cereals, corn chips and puffs, snack bars, cookies, doughnuts, croutons, breadsticks, baby foods and more.

Extrusion technology is efficient and economical. It allows manufacturers to make a wide range of shelf-stable, ready-to-eat foods.

But the process also appears to accelerate the speed at which our digestive tracts absorb glucose and other nutrients from food, causing greater spikes in blood sugar and insulin levels, [studies show](#).

“Extrusion cooking at very drastic pressures and temperatures is a kind of predigestion of your food,” said Anthony Fardet, a nutrition scientist at the French National Institute for Agriculture, Food, and Environment who studies the effects of food processing on health.

Fardet and his colleagues have found in their studies that ultra-processed foods are less satiating than minimally processed foods and that they have a more potent effect on blood sugar levels.

“Ultra-processing breaks the links between nutrients, it creates new links that our bodies may not recognize, and by doing this it disturbs the digestive process,” he said.

Finding your bliss point

Extrusion cooking turns grains and starches into wads of carbohydrate that can be easily chewed without sticking to your teeth, allowing for faster eating, swallowing and absorption, said David Kessler, the former head of the Food and Drug Administration and the author of “Fast Carbs, Slow Carbs.”

But perhaps most importantly, these foods are used as “delivery devices” for sugar, salt, fat and countless flavors and additives. They serve as a “palette,” said Kessler, for the “rainbow of flavors” that food companies use to make their products irresistible in a way that can trigger compulsive eating.

Ultra-processed foods are formulations of purified ingredients that are designed to achieve a certain “bliss point,” which prevents us from being able to regulate how much we eat, says Carlos Monteiro, a nutrition professor at the University of São Paulo.

“The way food is processed today has completely changed,” Monteiro added. “We’re putting inside of our bodies a lot of chemical compounds that are not nutrients — things that shouldn’t be in food.”

A new way to classify food

Monteiro developed what is now known as the NOVA classification system for identifying ultra-processed foods after noticing startling changes in Brazil’s food system and obesity rates, which skyrocketed from just four percent of adults in 1975 to roughly 26 percent of adults today.

Monteiro discovered that Brazilian families were increasingly replacing homemade meals with cheap and convenient alternatives — things like soft drinks, breakfast cereals and snack bars made by transnational food companies.

The NOVA system identifies four food groups based on how little or how much has been done to a food.

The first is unprocessed or “minimally processed foods” obtained directly from plants or animals with little or no alteration, like whole grains, vegetables, eggs, milk and meat.

Unprocessed or minimally processed foods

Group 1



Apple

The second group, “culinary ingredients,” includes things that people use to cook and season foods in homes and restaurants: oils, butter, sugar, spices, and salt, for example.

Processed culinary ingredients

Group 1



Apple

Group 2



Home-baked
apples

Making up the third group are “processed foods” such as canned vegetables, bacon, cheeses and freshly made breads. Processed foods contain multiple ingredients, but they are still “recognized as versions of the original foods.”

Processed foods

Group 1



Apple

Group 2



Home-baked
apples

Group 3



Packaged
applesauce cups

Then there are ultra-processed foods, which NOVA defines as “industrial formulations” made up entirely of substances extracted from other foods or “synthesized in laboratories.” These foods are manufactured through industrial techniques like “extrusion, molding and preprocessing by frying,” and the additives they contain are used to make them “hyper-palatable.”

Ultra-processed foods



Supporting ultra-processed food

Ultra-processed foods have many defenders who say people shouldn't be discouraged from eating affordable, nutrient-enriched foods with a long shelf life.

Hitchcock, from the [Institute of Food Technologists](#), said the NOVA system “does not capture the nuance” to help consumers identify healthful processed foods.

“Many ultra-processed foods deliver on nutrition, convenience and more while others are high in sodium, added sugar and unhealthy fats,” Hitchcock said. “Clarifying which to include more often, and which to reserve for occasional consumption, is essential.”

One prominent critic of the NOVA system is Rick Mattes, a nutrition scientist at Purdue University. Mattes served on the federal government's Dietary Guidelines Advisory Committee and works closely with the food industry. He sits on the scientific advisory board at Mars, the candy-maker, and [the Grain Foods Foundation](#), a trade group that represents the baking and milling industries.

Mattes said that the large number of epidemiological studies linking ultra-processed foods to poor health don't prove cause and effect or identify any mechanisms that would explain why they're harmful.

Urging people to avoid a broad category of foods could do serious harm, Mattes said. Many packaged foods are enriched or fortified with vitamins and minerals, including “shortfall nutrients” that a lot of Americans don't get enough of.

“We have to run clinical trials and study mechanisms,” he said. “Without mechanisms we don't know what is responsible in these foods, and as a result we don't know what to tell people to minimize or avoid.”

Eating 50 calories a minute

For a time, Kevin Hall, a nutrition and metabolism scientist at the National Institutes of Health, was also skeptical that ultra-processed foods were harmful.

To test the idea, he designed a study that compared what happened when men and women were recruited to live in a lab and fed different diets. In one phase of the study, the participants ate mostly ultra-processed foods for two weeks. Their daily meals consisted of things like honey nut oat cereal, flavored yogurt, blueberry muffins, canned ravioli, steak strips, mashed potatoes from a packet, baked potato chips, goldfish crackers, diet lemonade and low-fat chocolate milk.

In a second phase of the study, the participants were fed a diet of mostly homemade, unprocessed foods for two weeks that was matched for nutrients like salt, sugar, fat, and fiber. Their meals consisted of foods such as Greek yogurt with walnuts and fruit, spinach salad with grilled chicken, apple slices, bulgur and fresh vinaigrette, and beef tender roast with rice pilaf, steamed vegetables, balsamic vinaigrette, pecans and orange slices.

In both cases, the participants were allowed to eat as much or as little of the foods and snacks as they wanted.

“If it was really about the nutrients — and not about the processing — then there shouldn’t be any major difference in calorie intake between these two diets,” said Hall. “I thought that was going to be the result of the study.”

But, he added, “I was hugely wrong.”

When people ate the ultra-processed diet, they consumed substantially more calories — about 500 more calories a day compared to when they ate the mostly unprocessed diet. The result: They gained weight and body fat.

The researchers also noticed a difference in how quickly the participants consumed their food. They ate the ultra-processed meals significantly faster, at a rate of about 50 calories per minute, compared to just 30 calories per minute on the unprocessed diet.

In an email, Hitchcock at the IFT called Hall’s study “landmark research with important insights.” But he said more research was needed. “The results created as many questions for research as it answered,” he added.

Mattes applauded Hall for doing a clinical trial on ultra-processed foods. But he said the study was small and showed a “cruise ship” phenomenon. People initially ate a lot more food on the ultra-processed diet, but their daily calorie intake trended downward throughout the course of the study.

“If you put people in a new environment and give them very palatable foods they’ll consume a lot of them for a while,” he said. “But eventually they’ll start adjusting.”

Pre-chewed food

Humans have been cooking, grinding, preserving and processing food for thousands of years. Cooking makes food easier to digest. It liberates nutrients, allowing our bodies to extract more fat, carbs and calories from our food. The advent of cooking helped give our ancestors the energy their bodies needed to gain weight and grow bigger brains.

Our bodies absorb more energy from meat and starches that have been cooked. But modern food technology takes processing to another level.

Fiber, a type of carbohydrate found in plant-based foods, is one of the main casualties of ultra-processing. Fiber slows digestion. It reduces blood sugar spikes, delays the return of hunger after you eat and travels down to your colon, where it nourishes the trillions of microbes that make up your gut microbiome. These microbes turn fiber into health-promoting compounds such as short-chain fatty acids.

A study published in May found that people absorbed significantly more calories when they ate a diet of highly processed foods compared to when they ate a mostly unprocessed, fiber-rich diet.

The highly processed foods — the researchers referred to them as “pre-chewed” — were quickly absorbed in the upper gastrointestinal tract, essentially starving the gut microbes that reside farther down in the colon. But on the unprocessed diet, people excreted more calories in their stool and lost slightly more weight and body fat. They had higher circulating levels of short-chain fatty acids and increased levels of GLP-1, a gut hormone that promotes fullness and satiety.

Can processed foods be reformulated?

Hall at NIH welcomes debate about ultra-processed foods. But he says his hope is that research into their health effects will galvanize the food industry to reformulate them so they're less harmful.

He's conducting a new study to determine whether the energy density of meals and the amount of hyper-palatable foods they contain are what drive people to gorge on them.

Hall expects the results to be published in 2025. In the meantime, his advice for the public is to reduce your intake of ultra-processed foods if possible — but he knows that this message for a lot of people isn't very practical.

“I know that it's only the privileged that can avoid these foods because they have the time, the money or the skill and ability to prepare alternatives,” he said. “For the rest of us who rely on ultra-processed foods — myself included — avoiding them is very difficult.”