CRISPR Foods: The Naturalness of Public Skepticism

Clustered regularly interspaced short palindromic repeat (CRISPR) is the latest gene-editing technique promising an exciting new era of nutrition: higher yields, better nutrient profiles, and decreased allergens, to name a few. Faster, cheaper and more precise than the "traditional" approaches to changing DNA (genetically modified/GM foods), this technique has another important advantage: it does not involve "foreign" genes. Instead of inserting genes from other unrelated species (perceived highly unnatural by opponents), CRISPR achieves desired traits by altering DNA of one species with a trait that *already* exists naturally. It is the latter distinction that gives science and industry hope that GM opponents will not meet CRISPR-edited foods with the same level of opposition. In fact, the U.S. Department of Agriculture (USDA) has already ruled that it does not need to approve new varieties made with gene editing, as the agency does not consider them GM products.

However, GM critics do not appear to discriminate the two methods: for example, a Greenpeace 2015 policy briefing is titled "*Gene-editing of plants- GM through the back door?"* while a popular anti-GM health website article reports on CRISPR's lack of regulation *"[...] Frankenfood tidal wave about to be unleashed*". As a researcher studying how people decide what constitutes a healthy diet, I would expect this reaction based on what we know about the way people perceive risks and process information. So why does CRISPR appear to receive the same opposition from skeptics and why are some people concerned with these technologies in the first place?

Risk perceptions of CRISPR and other technologically novel foods

If we consider the cognitive and evolutionary mechanisms involved in food preferences, genetic modification and editing are unsurprisingly controversial. In fact, findings from risk perception research explain this opposition, as we know that people's perceptions are systematically biased to exaggerate risks if a potential hazard is viewed as involuntary, catastrophic, dreadful (frightening), and unknown.

As food generalists or omnivores, humans already display a fear of new foods, and precise gene editing in a lab via CRISPR is indeed novel. As people across the world exhibit biophilia (feelings about the superiority of the natural order and preference for natural), unnaturalness tends to be viewed negatively. The use of genetic modification in food can elicit especially strong negative images, such as metaphors of death and terrorism. Even though CRISPR-edited foods involve less modification than traditional GM foods, the public might view both to be equally unnatural because the *process* of the transformation itself can be more crucial for people's judgments than the differences in the content of the final product.

Another reason for why CRISPR-edited products might receive the same level of concern as GM foods is the way humans process information. Specifically, when making complex choices, such as deciding what is healthy and unhealthy to eat, we tend to use mental shortcuts or "cognitive heuristics" to simplify the process. Such shortcuts or "rules of thumb" include creating simple healthy/unhealthy dichotomies to categorize foods, or relying on emotional images associated with the product. While these heuristics help save effort in decision-making, they often do so at the cost of accuracy.

Power of emotion: the affect heuristic

Strong negative images related to "unnatural" genetic tinkering of the food supply are crucial for judgments of food risks. Some theorists argue that people's judgments are *first* based on automatic affective reactions, and are only then followed by cognitive processes of information processing. In other words, people appear to evaluate hazards to health first by how they feel about them instead of what they know and think about them. This is the affect heuristic.

It would appear true for GM concerns, as public worries persist despite scientific consensus on their safety. Reliance on emotions might also be evolutionarily wired. According to the "dual-process theories" of information processing, people apprehend reality in two fundamentally different ways: an intuitive, automatic and experiential system (System 1) and an analytical, rational, and deliberative system (System 2). System 1 is considered evolutionarily older, unconscious, one that requires low effort, and encompasses the affect heuristic. System 2 is more recent, conscious, and slow. Thus, relying on emotion in decision-making can be at least partially "hardwired" in humans (and appears to rely on evolutionarily older brain structures).

Hardwired to overreact: the dose-insensitivity heuristic

Another common heuristic employed in dietary choices is creating the simplest classifications (dichotomies) to denote good or bad foods. Preference for dichotomies can be attributed to the general inclination towards dose-insensitivity- the belief that if something is harmful at large doses, it is also harmful in small ones. Thus, public perceptions may be geared towards the all-or-nothing views: if a food uses *any* novel technology, whether it involves a DNA edit within a species or transferring genes between unrelated ones, it can be perceived as unnatural and thus bad.

Insensitivity to context may seem like a poor decision-making approach, but it can make sense in the light of evolution. According to the Smoke Detector Principle, when assessing harm the optimal response should in fact be overresponsiveness. A good smoke detector is sensitive to anything resembling smoke from a fire, and is thus prone to many false positive errors- it often mistakenly goes off when no real fire is present. Yet while this might be irritating to the homeowner, the cost of a false negative (failing to detect real fire) is much higher and possibly fatal.

The same principle is true with our own responses to potential harm (termed the behavioral immune system), which have evolved to minimize the likelihood of false negative errors. It is indeed better to run away from any suspicious sound in the grass even when it is simply caused by the wind (false positive error) than failing to run away when an actual predator is present (false negative error). Similarly, novel food technologies like CRISPR can activate our evolved psychological mechanisms of overcaution.

Alleviating public concerns

Advanced technology appears to be the perfect target for innate opposition that can be difficult to change. However, there are strategies of decreasing perceived harm, such as increasing familiarity with the technology- e.g., clear communication of its uses, opportunities, and limitations with the public. However, efforts at increasing public knowledge by the scientific

community and industry are likely to encounter two major difficulties: *negativity bias* and the issue of *trust*.

First, people consider health information asymmetrically: they give more value to and have more confidence in negative information (e.g., potential risks). Consequently, providing *more* information (both about benefits and risks) might only increase anxiety and fear. Second, when it comes to food technology, knowledge heavily depends on trust. While humans are great intuitive toxicologists via our sense of taste, smell, and sight to detect unsafe foods, we are not equipped to assess potential dangers of edited or modified foods on our own, and thus rely on experts to ensure safety.

Trust happens when people assume similarity in values with other people or social institutions. Thus, the popularity of celebrity health advice: if you are a parent trying to feed your children a healthy diet, you may be drawn to opinions of a public figure who, despite lacking scientific credentials, shares your worry for the nutritional wellbeing of their family.

Lastly, as uncontrollability is a known element of exaggerated risk perceptions, increasing perceived control over food choice might be crucial. The lack of regulation seen so far with CRISPR-edited foods could make people's opposition to this method even stronger than that for transgenics, which face significantly higher cost and time constraints.

Considering the human predisposition for exaggerated risks of unfamiliar novel hazards and anxiety over human interference with the "natural" order, creating acceptance for CRISPR-edited foods – and other novel foods as we develop the technology - will take active public engagement with a focus on transparency and listening.