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FOOD AVERSION AND PREFERENCE LEARNING IN HUMANS

To survive, animals must select, from among myriad nonnutritive and toxic items they could ingest, those few that are both nutritious and relatively toxin-free. Humans are, of course, animals, and many of the behavioral processes that guide the food choices of other animals influence humans' food choices as well. However, diet selection by humans is unusual in at least two ways. First, most human knowledge about foods comes secondhand, either directly or indirectly from others. Second, the feeding environment of humans living today in the developed world is dramatically different from that in which humans evolved their abilities to choose foods. We experience food excess, rather than food shortage, extraordinary variety in available foods, rather than restricted food choices, and we are exposed to foods with artificially enhanced palatability. Consequently, our evolved mechanisms of food choice, selected for in widely different circumstances, may sometimes prove maladaptive in the modern world.

Dietary Specialists and Dietary Generalists

Solving the problem of diet selection is relatively simple for animals that eat only one food. Such animals tend to evolve sense organs that identify the chemical signature of whatever species they find edible. For the tobacco hornworm, as its name implies, leaves of the tobacco plant are food, and the worm's taste receptors are particularly sensitive to chemicals found in tobacco leaves.

For dietary generalists—animals that, like humans, compose a diet consisting of many different foods—there is no chemical signature that allows discrimination of food from nonfood items. Dietary generalist have inherent sensory-affective systems biasing them to ingest substances with certain tastes or smells; at birth, human infants like the taste of sugar and reject the bitter of quinine and the sour of lemons. However, dietary generalists still must learn which specific items to ingest and which to avoid eating.

Learning to eat nutritious foods while avoiding toxic or worthless potential foods is especially difficult because effects of toxins and nutrients often occur long after their ingestion. Consequently, many animals, humans included, have evolved a special type of conditioning, called *taste-aversion learning* (discussed below as a type of evaluative conditioning), allowing them to bridge the temporal gap between ingesting an item and experiencing consequences of its ingestion.

Human Food Rejection and Acceptance

Humans reject potential foods for one or more of four reasons. They may find a food distasteful, rejecting it because it has undesirable sensory properties. Alternatively, a food may be rejected because it is perceived as dangerous, for instance, as causing illness such as allergic reaction. A potential food may also be rejected because it is viewed as inappropriate, as, for example, is dirt. Last, some foods may not be eaten because they seem disgusting, as with rotting meat, which is viewed as disgusting by members of some cultures, but not others.

There are only two categories of accepted items: those that taste good and, like diet soda, are consumed because of their sensory properties, and those consumed because they are believed to produce positive consequences, as are health foods, and medicines. Many accepted items have both properties.

Effects of Exposure and Conditioning

Generally, previous exposure of either humans or other animals to a food without obvious positive or negative consequences ("mere" exposure) tends to increase liking for that food. On the other hand, a great deal of exposure to a food in a brief period can produce a temporary decline in liking labeled *sensory-specific satiety*. Too much of even a good thing can produce temporary avoidance of it.

A further means of changing response to food preference involves a form of classical conditioning called *evaluative conditioning*, of which taste-aversion learning is one example. In evaluative conditioning, affective response to a stimulus (a conditioned stimulus, or CS) is changed as a result of pairing with either a liked or disliked stimulus (an unconditioned stimulus, or UCS). In the case of taste-aversion learning, if an animal such as a rat or a human eats a relatively unfamiliar food and, within a few hours, becomes nauseous, the sick individual will develop a distaste for the smell and taste of the food ingestion of which preceded illness. Such taste-aversion learning, reflecting a change in affective response to a food, can seem irrational, occurring even if the sick individual "knows" that the food did not cause the nausea (for example, the nausea might clearly be a symptom of the flu).

Taste-aversion learning differs from situations in which ingestion of a food is followed by negative effects other than nausea: for example, hives or respiratory distress. In the latter case, people can learn that a potential food is dangerous and should not be eaten. However, the taste of the food does not become unpleasant, and the victim of an allergic reaction may continue to want to eat the food causing distress, but will avoid doing so from fear of the consequences. For example, a person who eats shrimp and becomes nauseated tends thereafter to dislike shrimp and may find even the smell of shrimp distasteful, whereas someone who experiences respiratory distress after eating shrimp will avoid eating shrimp but may still like their taste and smell. Nausea serves as a special UCS that, when paired with a food, even once and with a lengthy delay between CS and US, often produces distaste.

In humans as in other animals, enhancement of liking for a neutral flavor can occur if it is paired with a desirable flavor, and pairing a neutral flavor with introduction of nutrients into the stomach also can increase liking for the previously neutral flavor. However, pairings of flavors with calories or good tastes usually has modest effects in comparison with pairings of flavors with nausea.

Social Influences on Human Food Choices

In humans, social forces account for many food preferences and aversions. Approval or disapproval of foods by respected others seems to influence one's own response to those foods, though the way in which such change occurs is not well understood. The process of change could be cognitive, could involve social learning, or could be a form of as-yet unexplored social, classical conditioning. In the last case, displays of pleasure, displeasure, or disgust by another could become associated with a flavor, changing affective response to it.

We do know that children show increased liking for foods associated with positive displays by significant others and that such socially induced changes in food preference can last for months. Changes in affective response to foods seem to occur when children do not feel forced or "bribed" to consume a food: when children are rewarded for eating a food, they do not tend to like it more. However, when the same food is either used as a reward or is seen to be enjoyed by others, it does become liked more. Social factors are almost surely also involved in the development of disgust responses, as when children observe negative responses of their parents to finding half a worm in a half-eaten apple or to body wastes. However, this process has not been investigated.

A distinctive feature of the human diet is that many foods that are liked by some humans have sensory properties that are inherently aversive to both other humans and other animals. Members of many cultures like bitter substances such as coffee, quinine water, and tobacco as well as irritants such as chili pepper and horseradish, substances that animals, infant humans, and adults from some other cultures find aversive. Such preferences may be learned in social settings, although we do not really know how.

Humans clearly differ from all other animals in the importance of *cuisine* (defined here as a system for selecting, processing, combining, and flavoring foods that incorporates the nutritional wisdom of past generations) in their food selection. Although social learning affects food choices of nonhuman animals (for example, after an "observer" rat interacts with a "demonstrator" rat that has eaten a food, the observer prefers the food its demonstrator ate), social influences on food choice are neither as pervasive nor as long lasting in nonhuman animals as in humans.

Young humans are also probably the only animals explicitly taught what to eat and what to avoid eating, although some evidence suggests that chimpanzees may have rudimentary abilities to instruct their young about foods. Still, only humans learn socially to give foods emotional, social, and moral values, and only humans learn about nutritive values, appropriate times for ingestion, and means of preparation of foods in a manner perhaps best described as social-cognitive, just as they learn about other aspects of the physical environment.

Conclusion

Unfortunately, not enough is yet known about the development of food preferences in the human species to give much helpful advice to parents wishing to modify a child's food choices. Indeed, one of the most surprising facts known about human food choices is that there is little similarity between food preferences of parents and their mature children. Important as teaching, social learning, and cuisine may be in shaping human food choices, other factors, as yet poorly understood, play a major role in shaping the dietary repertoires of humans.

See also: TASTE AVERSION AND PREFERENCE LEARNING IN ANIMALS

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Paul Rozin

Revised by Bennett G. Galef Jr. and Paul Rozin

FORAGING

Foraging, the search for food, is a fundamental part of behavior. All animals, from the simplest invertebrates to primates, have to take in food. Because appropriate food may be more abundant at some times and places than others, an animal that can learn about the characteristics of its food supply is likely to be able to forage more efficiently than one that cannot learn. Indeed, the need for efficient foraging creates a strong selection pressure for the evolution of learning and memory.

Since the late twentieth century, the study of foraging behavior has been guided by *optimal foraging theory*, a body of mathematical models specifying how animals should behave so as to maximize foraging efficiency. After briefly introducing this framework, this