Acquisition of Stable Food Preferences

Paul Rozin, Ph.D.

Although biologically food is simply a source of nutrition, for humans it is much more than that. It provides one of the major sources of pleasure to our species. Within the context of culture, food also functions as a social and moral instrument. However, these effects are muted in modern Western industrialized cultures; we purchase highly processed foods and foods whose personal origins are shielded from us by the mediation of plastic wrap and impersonal employees of a supermarket. For many humans, e.g., hundreds of millions of Indians, food is intimately tied to its personal origins; the identity of the person who prepared a food is a major factor in its acceptance. One's social/moral standing is at risk when one consumes food prepared by a person of lower caste rank, or when one violates a food taboo. More generally, there is a widespread belief, overt in traditional cultures and more subtle in developed cultures, that one takes on the properties of what one eats ("you are what you eat"). Such a belief can strongly influence food preferences, causing avoidance, e.g., of "female" foods by males, or avoidance of animal foods on the grounds that they will make one more like an animal.[1,2]

People spend much of their waking time earning money to purchase food, as well as in the food-related activities of cooking and eating. If the sole aim was nutrition, people could spend much less of their money and time on eating. The fact is that food preferences are heavily determined by the desire to maximize pleasure. In this presentation I shall emphasize the role of nutrition and pleasure in food preferences. I will pay rather little attention to the powerfully important social/moral factors, except insofar as they contribute to the pleasure of eating. In a brief review such as this, attention will be further limited to stable food preferences, i.e., preferences that remain from meal to meal, day to day, and month to month. Many preference changes, e.g., those determined by degree of satiety[3] and the particular foods recently eaten,[4] might be the subject of another essay. (For more detailed reviews on food selection, see references 5–13.)

Dr. Rozin is Professor of Psychology in the Department of Psychology, University of Pennsylvania, 3815 Walnut Street, Philadelphia, PA 19104-6196.

Preference and Liking

Preference implies choice. To prefer a food is to choose it over another designated food (or other activity). For many people in the world, food intake is largely controlled by availability and cost, so that choices are limited and the mapping between actual foods eaten (use) and preference is rather weak. In more affluent cultures, as availability and cost recede in importance, preference is more in line with use.

Preference is a behavioral term; it is not a mechanism but rather a description of behavior. Liking, on the other hand, is a mental term, which serves both to describe some aspects of food choice and to explain them. Thus, one might say, "I prefer apple to pineapple because I especially like the flavor of apples." This need not be true. For example, one might prefer apple but like pineapple better, as in a case of allergy to pineapple. Liking is a major cause of preference but not the only cause. As with the use/preference comparison, as certain constraints (in this case, health and social factors) fall into the background, liking becomes equivalent to preferring. For flavor variants of the same basic food, preference usually amounts to liking and the terms are sometimes used as equivalents.

The simplest classification of potential foods, for any individual or any culture, might be those that are eaten and those that are avoided. Further analysis indicates that within these broad categories, three types of reasons account for the particular psychologic nature of an accepted or rejected food. Some foods are rejected or accepted on the basis of their sensory properties: we like or dislike their taste, smell, or appearance. We call foods accepted primarily on these grounds *good tastes* and those rejected *distastes.*[12,14] Other foods are rejected or accepted primarily on the basis of anticipated consequences of ingestion. Foods rejected because of presumed bad consequences we classify as *dangerous,* whereas those accepted for their positive effects we call *beneficial.* In the domain of food rejection, there is one more prominent motive for rejection, which we call ideational: concern about the nature or origin of the item in question. The great majority of items that are not eaten are simply thought to be inedible; we learn almost invariably through cultural mediation that things such as paper, grass, wood, glass, etc. are not food (what we call the *inappropriate* category). Finally, the most powerful rejection is defined by both ideational and bad-taste reasons. These items we call *disgusting;* they are rejected because of their very nature, but we are sure that they taste bad (as, e.g., feces in all cultures and insects in U.S. culture). Disgusting items are almost always animal in origin and hence are potentially nutritious, whereas inappropriates are usually of minimal (if any) nutritive value.[15,16]

Genetic Determinants of Food Preferences

Humans, rats, and cockroaches are among the most successful species in the world. All owe part of their success to their omnivorous food habits; they can find nutrition in almost any environment, and they exploit a wide range of foods. Since there is no simple way to detect nutritional adequacy or the absence of toxins by sensory means, omnivores must basically learn what is edible and what is not. Thus, a biologic fact about omnivores is that relatively few genetic factors control their food selection. However, there are some genetically determined biologic biases in food selection.[10]

Taste Biases

Many mammalian omnivores, including both rats and humans, have a genetically determined bias to accept sweet tastes and to avoid bitter tastes. These biases are in accord with some basic ecologic facts: in nature, sweetness predicts energy value, and bitterness predicts toxicity (e.g., alkaloids and glycosides, two very common classes of plant poison, both taste bitter). The innateness of these preferences is attested to by the fact that human infants, tested before they have ever consumed food, show facial expressions indicative of rejection when given bitter solutions and show acceptance when sweet solutions are presented.[17,18]

It is likely that humans and other omnivorous mammals have other taste biases, but none has been definitively identified. Candidates include a negative response to oral irritation (e.g., as induced by chili pepper) and positive responses to fat, protein, and/or amino acids.

Novelty and Familiarity

A second bias, studied most intensively in the rat,[10,19] is a tendency to be suspicious of new foods. However, there is also a curiosity about new foods, resulting in ambivalent behavior to them (the omnivore's dilemma).[10]

Genetically Influenced Learning Abilities

A third genetically based bias is an ability to learn promptly about the delayed effects of ingested foods. Whereas most learning requires a brief time interval between events being associated, associations between foods ingested (usually tastes) and the metabolic consequences of ingestion may occur with intervals of hours. This phenomenon is most clear in learning by rats (but also humans) to avoid toxic foods.[20] Finally, in the case of humans, there is the special biologic endowment of a brain and plasticity that allows for reasoning, hypothesis testing, and experimentation. Thus, by experimentation humans can learn what made them sick or what might make them better. This knowledge can then be passed along to contemporaries, or by oral or written tradition, to descendants.

Innate Specific Hungers

In his classic work Curt Richter[21] showed that rats were able to choose among a set of foods in such a way as to correct nutritional deficiencies. Richter and his followers demonstrated such specific hungers for sodium, calcium, and other minerals, for a variety of vitamins, for protein and some specific amino acids, as well as for carbohydrate and fat. In order to qualify as innate, as Richter supposed, one would have to demonstrate that the rat had both an innate recognition of the specific nutrient and a recognition of the internal deficiency state associated with that nutrient, so that the animal would be able to search out the needed nutrient. Such a combination of innate capacities has been clearly demonstrated for sodium hunger.[21] Rats deficient in sodium for the first time show an immediate preference for substances with high sodium content. There is a parallel specific hunger for water (with an innate state of thirst, triggering a search for an innately specified entity, water), and it is possible that there are innately programmed hungers for protein, energy in the form of carbohydrate, and calcium. However, only those hungers for sodium and water have been documented.[10,13] There is some evidence that a specific hunger for sodium may be innate in humans.[22] For the great majority of nutrient deficiencies, rats and humans learn what foods are causative and curative.[10]

Genetic Bases for Individual Differences

Very little of the substantial individual differences in food preferences can be attributed to genetic factors. However, there are two documented routes for such influence. One involves differences in the sense of taste. For example, inherited differences in sensitivity to a class of bitter compounds has been related, in a modest way, to preferences for bitter foods.[23] More significant are the wide variety of metabolic differences that have genetic bases. These metabolic differences, when they promote deficiencies, provide the motivation for learning of specific food preferences. For example, differences in enzyme levels have been related to culture-specific food preferences for substances as diverse as fava beans and milk.[24,25]

The Limits of Genetic Mechanisms

It would be surprising, given what has been said, if genetic factors were sufficient to guarantee adaptive food selection. Classic self-selection studies done with rats by Richter[21] and with newly weaned human infants by Davis[26] suggested adaptive food selection in need-free (nondeficient) organisms. Although there is no doubt that the rats and humans sustained good growth on a self-selected diet, this result does not support the sufficiency of innate capacity. First, the choices offered to rats and humans were such that random broad selection might have sufficed for normal growth. There is no definitive evidence for an ability to select nutrients adaptively in the need-free state, unless there has been prior experience with deficiencies. Second, any adaptive choice that may have occurred in these types of cafeteria experiments could have resulted from learning.

Cultural Determinants of Food Preference

In contrast to the situation with nonhuman animals, food preferences of humans show a predominant influence of cultural factors. Only humans have a body of culturally transmitted nutritional beliefs, values, preferences, and modes of food preparation and serving (cuisine). Indeed, if one wished to know as much as possible about an individual's food preference, the best question to ask would be, "What is your culture or ethnic group?" Of course, *culture is the product of individual* humans, so biologic biases in individuals may appear in cultural traditions. Thus, the extensive use of sugar and artificial sweeteners in many cuisines may be traced to the innate liking for sweet.[11,27] Similarly, learning about food processing, which is transmitted through culture, accounts for many elaborate technologies, such as the improvement of the nutritional value of corn by the making of tortillas[24] or the fermentation of milk to digest externally otherwise indigestible lactose.[25] However, culture can also influence our biology. Lactose tolerance, a genetically based trait, almost certainly results from a selection pressure resulting from the domestication of animals and the availability of raw milk to our ancestors.[11,25]

Within-Culture Variance in Preferences: The Family Paradox

Cultural factors cannot explain the widespread individual variation in preferences that occur across members of the same culture. These variations must be attributable to either genetic differences or differences in individual experience (acquisition). The most obvious source of that experience is parental influence, especially that of the mother, who, in traditional settings, supervises both food preparation and feeding. It is very surprising and disturbing to note that parent–child resemblance in food preference is very low: correlations range from zero to about 0.25.[28–30] Note that family resemblance includes both genetic and experiential factors, so that this low correlation is the more surprising. Evidence from twins[31,32] indicates a very small role for heredity, a fact suggesting that most of the modest family-resemblance correlations are attributable to a common environment. The family results are paradoxical because culture-based preferences are almost surely communicated, in substantial part, by experience in the family environment. If the family is effective at doing that, why is it not effective in communicating its unique preferences?

The paradox is expanded by the finding that the mother–child correlation is not significantly or reliably higher than the father–child correlation.[28–30] Any reasonable theory would attribute a greater environmental influence to the mother. If most within-culture variance is environmental, but not familial, where does it come from? There are rather small effects of gender and age.[33] Idiosyncratic events, personality differences, and peer or teacher influences are possible but have yet to be explored. What remains is a mystery.

One might expect family effects to be greatest in the first five years of life, when the family has the greatest control over the child's feeding. However, although there *is* evidence for the effects of early experience on later food choice,[5] there is no evidence that early experience is more important than later experience. This makes adaptive sense for mammals. Their earliest food, milk, is one that is unavailable (except for those humans in dairying cultures) after weaning. A strong preference for an unavailable food would be maladaptive.[34]

The Acquisition of Likes and Dislikes for Foods

The major conceptual problem in this field, aside from the family paradox, has to do with the processes that cause foods to acquire bad or good tastes. It is not puzzling that a food is avoided (dangerous category) because one learns through direct experience or by a social route that it causes harm, or that a food is consumed because it has positive effects (beneficial category). The puzzle is that some foods come to be liked or disliked, i.e., consumed or avoided, because of their intrinsic sensory properties. The acquisition of likes is of significance in public health because it is much easier to maintain ingestion of a food that is liked and to maintain avoidance of the food that is disliked. Hence, to foster better food habits, it is most desirable to create appropriate likes and dislikes. Unfortunately, we know little about the mechanisms involved. I shall review, in turn, the acquisition of three types of liking change: distastes, disgusts, and good tastes.

The Acquisition of Distaste

There is one very well-established mechanism for change in liking in the food domain, and it has to do with the creation of distastes. For rats[35,36] or humans,[37] when ingestion of a food is followed by malaise, particularly nausea, the food tends to become disliked. This conditioned taste-aversion[20] is a form of Pavlovian conditioning. The special potency of nausea is striking, since life-threatening allergic responses that do not include nausea typically produce a danger characterization of the food but not a distaste. People with allergies typically treat the allergic food as dangerous but not distasteful.[37] There are many distastes in the food repertoire of most people, and it is unlikely that nausea-based taste aversions account for most. We have no direct evidence for the other mechanisms that must be involved.

The Acquisition of Disgust

We define disgust as "revulsion at the prospect of oral incorporation of an offensive substance. The offensive objects are contaminants; i.e., if they even briefly contact an acceptable food, they tend to render that food unacceptable."[15,16] Feces are universally considered to be disgusting, and almost all substances that meet the criterion set in the definition of disgust are of animal origin. There is no evidence of an innate basis for this category. Furthermore, there is no evidence for anything like disgust in a nonhuman animal. We do not know how disgust is acquired. One possibility is Pavlovian conditioning, which would result from a pairing of feces (as a conditioned stimulus) with negative emotional expressions in parents (the unconditioned stimulus), presumably during toilet training. This process might establish the first and universal disgust, and others might be acquired by a similar type of conditioning, or by pairing of a new item with an already disgusting item.[16] Alternatively, *disgust may be a cognitive category*; reservations about eating animals, because of both moral issues and the prospect of incorporating the animal's qualities, might cause strong negative response. Very little is known about this acquisition process, but clearly, it is an acquisition process.

The Acquisition of Likes (Good Tastes)

There is no single highly potent mechanism for the acquisition of likes operative in both animals and humans that might correspond to the role of nausea in distaste. As with distaste, Pavlovian factors seem of paramount importance.[38] Unlike the development of distastes, as currently understood, there is a powerful role for social factors in the generation of likes. It is difficult to make the like/preference distinction with animals, although it is possible to do so by using facial expressions.[35,36,39] For this reason most of the research reviewed deals with humans. However, for some purposes, increases in preferences shown by animals can be interpreted as increases in liking.

Nonsocial Factors

The simplest way to account for acquired likes is mere exposure; simple exposure without any obvious consequences may produce increased liking.[40] The mechanism is unknown, although it may be, in part, dissipation of the fear of a new food.

In a Pavlovian framework, if we think of a food as a conditioned stimulus, two types of nonsocial unconditioned stimuli have been shown to enhance liking. One is the positive postingestional consequence, usually associated with reduction of hunger. Rats and humans learn to prefer (like) foods of high caloric value, if fed these foods when hungry.[8,41] In general, these enhanced liking effects require more trials and are less robust than the conditioned taste aversions. However, by use of partially hydrolyzed starch (polycose) as the unconditioned stimulus, it was recently possible to produce strong enhancements of flavor preferences in rats.[42] A second effective unconditioned stimulus is an already-liked taste. Several studies on both rats and humans have shown that there is increased preference or liking for flavors that are paired with sweetness.[43,44]

Social Factors

Social factors may be the most potent means of enhancing liking in humans. Such factors have proved to be highly effective in rats, where exposure to a conspecific who has eaten a food enhances preference for that food and makes it resistant to subsequent aversion-conditioning.[45] Social forces work in two ways in humans. Indirectly, through cultural mediation, social factors control what foods are experienced, and in what combinations. For example, coffee is frequently drunk, at first, with much milk or cream and sugar. Later, these palatable components may fade away. This coffee/cream/sugar coupling is a form of Pavlovian conditioning of the type described previously, but it is programmed by culture. Social factors also serve to modulate liking directly, as when an adult shows pleasure at consuming a food, and a child notes this adult response and shows an enhanced liking. This process may be viewed as a form of Pavlovian conditioning in which the positive effect shown by the other person is the unconditioned stimulus. Birch[6] conducted a series of definitive experiments showing that children come to like foods more if they perceive that peers or respected others enjoy these foods. These effects are substantial and long-lasting.

Birch et al.[46] added a fascinating twist to this story. If children are given a reward for eating a particular food, their preference for the food increases. However, when the reward is discontinued, their preference drops to below its initial level. The interpretation of this decrease in preference is that the reward indicates that a bribe is needed to eat the food, i.e., the food is not good in itself. This perception by the child may prevent acquisition of a liking.

Acquired Likes for Innately Unpalatable Foods

Humans develop likings for a set of foods that are innately unpalatable. The most common classes of such foods are bitter and irritant. These likes could result from the mechanisms we have already discussed. It is also possible that the initial negativity of these foods may be a factor in the acquired liking. For example, the initial negative response may be accompanied by endorphin secretion, which might increase with successive encounters, leading to a pleasant outcome. Alternatively, the thrill-seeking aspect of consuming such foods may lead to pleasure. Chili pepper is harmless, but it activates strong bodily mechanisms of rejection. Perhaps the appreciation of the fact that the body is signaling harm but that it is really safe is a source of pleasure.[47]

In summary, there is much more to discover than there is already known in the area of food selection. However, the methodology for extension of our knowledge is in place, and we can look forward to greatly increased knowledge about the acquisition of food preferences in coming decades.

Acknowledgments: Preparation of this paper was assisted by grants from the John D. and Catherine T. MacArthur Foundation Research Network on Health-Related Behaviors, and from the University of Pennsylvania Research Fund.

---

1. Meigs AS. Food, sex, and pollution: a New Guinea religion. New Brunswick, NJ: Rutgers University Press, 1984
2. Nemeroff C, Rozin P. An unacknowledged belief in "you are what you eat" among college students in the United States: an application of the

demand-free "impressions" technique. Ethos. J Psychol Anthropol 1989;17:50–69
3. Cabanac M. Physiological role of pleasure. Science 1971;173:1103–7
4. Rolls BJ, Hetherington M, Burley VJ, van Duijvenvoorde PM. Changing hedonic responses to foods during and after a meal. In: Kare ML, Brand RG, eds. Interaction of the chemical senses with nutrition. New York: Academic Press, 1985:247–68
5. Beauchamp, GK. Ontogenesis of taste preference. In: Walcher D, Kretchmer N, eds. Food, nutrition and evolution. New York: Masson, 1981:49–57
6. Birch, LL. Children's food preferences: developmental patterns and environmental influences. In: Whitehurst G, Vasta R, eds. Annals of Child Development. Vol. 4. Greenwich: CT: JAI, 1986:171–208
7. Blundell JE. Problems and processes underlying the control of food selection and nutrient intake. In: Wurtman RJ, Wurtman JJ, eds. Nutrition and the brain. Vol. 6. New York: Raven Press, 1983:163–221
8. Booth DA. Normal control of omnivore intake by taste and smell. In: Steiner J, Ganchrow J, eds. The determination of behaviour by chemical stimuli. ECRO symposium. London: IRL Press, 1982:233–43
9. Krondl M, Lau D. Social determinants in human food selection. In: Barker LM, ed. The psychobiology of human food selection. Westport, CT: AVI, 1982:139–51
10. Rozin P. The selection of food by rats, humans and other animals. In: Rosenblatt J, Hinde RA, Beer C, Shaw E, eds. Advances in the study of behavior. Vol. 6. New York: Academic Press 1976:21–76
11. Rozin P. Human food selection: the interaction of biology, culture and individual experience. In: Barker LM, ed. The psychobiology of human food selection. Westport, CT: AVI, 1982:225–54
12. Rozin P, Vollmecke TA. Food likes and dislikes. Annu Rev Nutr 1986;6:433–56
13. Rozin P, Schulkin J. Food selection. In: Stricker EM, ed. Handbook of behavioral neurobiology. Vol. 10. Food and water intake. New York: Plenum Press (in press)
14. Rozin P, Fallon AE. Psychological categorization of foods and non-foods: a preliminary taxonomy of food rejections. Appetite 1980;1:193–201
15. Angyal A. Disgust and related aversions. J Abnorm Soc Psychol 1941;36:393–412
16. Rozin P, Fallon AE. A perspective on disgust. Psychol Rev 1987;94:23–41
17. Steiner J. Facial expressions of the neonate infant indicating the hedonics of food-related chemical stimuli. In: Weiffenbach JM, ed. Taste and development: the genesis of sweet preferences. Bethesda, MD: U.S. Department of Health, Education, and Welfare 1977:173–89
18. Rosenstein D, Oster H. Differential facial responses to four basic tastes in newborns. Child Dev 1988;59:1555–68
19. Barnett SA. A study in behaviour. Principles of ethology and behavioral physiology, displayed mainly in the rat. London: Methuen, 1963
20. Garcia J, Hankins WG, Rusiniak KW. Behavioral regulation of the milieu interne in man and rat. Science 1974;185:824–31
21. Richter CP. Total self regulatory functions in animals and human beings. Harvey Lect 1943;38:63–103
22. Beauchamp GK, Bertino M, Engelman K. Modification of salt taste. Ann Intern Med 1983;98:763–9
23. Fischer R, Griffin F, England S, Garn SM. Taste thresholds and food dislikes. Nature 1961;191:1328
24. Katz SH. Food, behavior and biocultural evolution. In: Barker LM, ed. The psychobiology of human food selection. Westport, CT: AVI, 1982:171–188
25. Simoons FJ. Geography and genetics as factors in the psychobiology of human food selection. In Barker LM, ed. The psychobiology of human food selection. Westport, CT: AVI, 1982:205–24
26. Davis CM. Self selection of diet by newly weaned infants: an experimental study. Am J Dis Child 1928;36:651–79
27. Mintz SW. Sweetness and power. New York: Viking, 1985
28. Birch LL. The relationship between children's food preferences and those of their parents. J Nutr Educ 1980;12:14–8
29. Pliner P. Family resemblance in food preferences. J Nutr Educ 1983;15:137–40
30. Rozin P, Fallon AE, Mandell R. Family resemblance in attitudes to food. Dev Psychol 1984;20:309–14
31. Greene LS, Desor JA, Maller O. Heredity and experience: their relative importance in the development of taste preference in man. J Comp Physiol Psychol 1975;89:279–84
32. Rozin P, Millman L. Family environment, not heredity, accounts for family resemblance in food preferences and attitudes: a twin study. Appetite 1987;8:125–34
33. Logue AW, Smith ME. Predictors of food preferences in adult humans. Appetite 1986;7:109–25
34. Rozin P, Pelchat ML. Memories of mammaries: adaptations to weaning from milk. In: Epstein

AN, Morrison A, eds. Progress in psychobiology. Vol. 13. New York: Academic Press, 1988:1–29

35. Parker LA. Nonconsummatory and consummatory behavioral CRs elicited by lithium- and amphetamine-paired flavors. Learn Motiv 1982;13: 281–303
36. Pelchat ML, Grill HJ, Rozin P, Jacobs J. Quality of acquired responses to tastes by *Rattus norvegicus* depends on type of associated discomfort. J Comp Physiol Psychol 1983;97:140–53
37. Pelchat ML, Rozin P. The special role of nausea in the acquisition of food dislikes by humans. Appetite 1982;3:341–51
38. Rozin P, Zellner DA. The role of Pavlovian conditioning in the acquisition of food likes and dislikes. Ann NY Acad Sci 1985;43:189–202
39. Grill HJ, Norgren R. The taste reactivity test. I. Mimetic responses to gustatory stimuli in neurologically normal rats. Brain Res 1978;143:263–79
40. Pliner P. The effects of mere exposure on liking for edible substances. Appetite 1982;3:283–90
41. Booth DA, Mather P, Fuller J. Starch content of ordinary foods associatively conditions human appetite and satiation, indexed by intake and eating pleasantness of starch-paired flavors. Appetite 1982;3:163–84
42. Sclafani A, Nissenbaum JW. Robust conditioned flavor preferences produced by intragastric starch infusions in rats. Am J Physiol 1988;255 (Regulatory integrative comparative physiology 24):R672–5
43. Holman E. Immediate and delayed reinforcers for flavor preferences in rats. Learn Motiv 1975;6: 91–100
44. Zellner DA, Rozin P, Aron M, Kulish C. Conditioned enhancement of human's liking for flavors by pairing with sweetness. Learn Motiv 1983;14: 338–50
45. Galef BG Jr. Communication of information concerning distant diets in a social sentral-place foraging species: *Rattus norvegicus*. In: Zentall T, Galef BG, Jr, eds. Social learning: a comparative approach. Hillsdale, NJ: Erlbaum, 1988:119–39
46. Birch LL, Birch D, Marlin DW, Kramer L. Effects of instrumental consumption on children's food preferences. Appetite 1982;3:125–34
47. Rozin P, Schiller D. The nature and acquisition of a preference for chili pepper by humans. Motiv Emot 1980;4:77–101