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FOOD LIKES AND DISLIKES

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INTRODUCTION

The mouth is the main route through which nutrients and most toxins enter the body. It is effectively the final point at which one decides whether or not to incorporate an item into one's body by swallowing (101). Consequently,

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people have strong feelings about objects that enter the mouth and the sensations they produce. *Like* and *dislike* are affective words that humans apply easily in discussing most potential foods. The nature and origin of these likes and dislikes are the focus of this review.

In humans, things almost invariably get to the mouth by action of the hands. So, with the exception of infants and seriously handicapped people, it is through our own behavior that we acquire nutrients. Given this central role of behavior in nutrition, it is striking how little we know of how and why particular items are ingested and how they come to be liked or disliked (for general reviews, see 4, 6, 55, 57, 94, 97, 98, 117, 124). Our lack of knowledge results both from the difficulty of the problem and from a relative paucity of research efforts in the area.

Before reviewing the literature, we introduce six distinctions or qualifications. The first is the difference between foods and nutrients. People eat foods, not nutrients. Although foods stimulate the chemosensory, visual, thermal, and tactile senses, it is the mental representation invoked by this stimulation that is critical to humans' response: we respond to the mental representation of foods in order to identify particular items as either edible or not. The food itself is at once a source of nutrition, a source of harmful microorganisms or toxins, a great source of pleasure and satisfaction, and a vehicle for the expression of social relations and values.

A second set of distinctions must be made among *use, preference,* and *liking* (73, 96). The most common and "objective" measure of food selection is *use*, i.e. what and how much a person eats. It is largely determined by availability and cost, and is not directly considered in this review. *Preference* assumes the availability of at least two different items, and refers to the choice of one rather than the other. *Liking* refers to a set of hedonic (affective) reactions to a food, usually indexed directly by verbal reports or rating scales, but sometimes indirectly by facial expressions. Preference is ordinarily taken to be synonymous with liking, but this is not necessarily the case. Liking is only one of the motivations that may account for a preference. Perceived health value, convenience, and economic factors are potent influences on preference (59, 110) but may not affect liking. A dieter, for example, may prefer cottage cheese to ice cream, but like ice cream better. Nonetheless, in most cases, we prefer those foods that we like better. We focus here on literature that addresses the ways foods come to be liked or disliked. In practice, however, this assessment is sometimes made with data on preferences. While it is important to recognize the liking-preference distinction, it is also necessary to recognize that most data do not permit us to draw this distinction.

A third distinction concerns the time frame in which a preference (or liking) is cast. Some aspects of liking (e.g. liking lobster more than tuna fish) hold for any individual over periods of years or even a lifetime. Although one's general interest in food may vary with state of repletion, the relative standing of items within a food category (e.g. seafood) tends to be stable. Such stable likes contrast with more labile likes, as in the shift from breakfast foods to other foods as the day progresses, or shifts in the types of foods liked as a function of repletion.

Fourth, preference and liking are abstractions, easily made by humans when called for. But to say one likes lobster does not mean that one likes it for breakfast or smothered in whipped cream. A statement of preference or liking presumes an appropriate context. What constitutes an appropriate context is largely specified by culture.

Fifth, although it is tempting to account for individual differences in preferences in terms of sensory differences, efforts to do so have met with little success. Neither thresholds nor individual scaled intensity functions are good predictors of individual preferences (5, 73, 74a).

Sixth, almost all the data reported in this paper come from British or North American subjects. These represent a small percentage of humanity, and may differ significantly from much of the world's population. In India, for example, food assumes a much more important role in communication and in regulation of the social hierarchy (2). This should not be considered a deviant role. It is not restricted to India, but even if it were there are more people alive in India today than in all of North and South America.

THE ORIGINS OF FOOD PREFERENCES AND LIKES

Besides availability and economic factors, all other determinants of food choice can be categorized as biological (genetically determined), cultural, or individual (psychological). These three categories can be applied to universals of human food preferences, to differences between cultures, and to individual differences within a culture.

Biological Factors

Biological explanations are more likely for universal features of food choice than for individual differences. But in examining food preferences of humans cross-culturally, one notes an enormous diversity. Universals are few. This follows in part from the fact that humans are omnivorous. They have general-purpose dentition and digestive systems and are inclined to exploit a wide variety of those foods that are locally available to them. Since it is not possible to specify completely, in advance, which sensory properties predict particular nutrients or toxins, the omnivore must discover what is edible (94). That is, it is fundamental to omnivore biology to have few biological predispositions about foods. There are many important biological determinants in the background, such as the nutritional needs of the organism and the particular classes of chemicals that the nose and mouth can detect. With specific reference to food choice, there are three well-documented, genetically based, behavioral predispositions in many mammalian omnivores and in other generalists.

First are innate taste biases. There is an innate preference and liking for sweet tastes, present at birth and measurable either by enhanced acceptance of sweetened water or by positive facial expressions (31, 35, 120, 123). Similarly, among adults in virtually all cultures, there is a liking for sweet items, though the most liked level of sweetness varies greatly from person to person (70, 72, 74). The preference for sweetness has an adaptive basis since, in nature, most items with a sweet taste are sugars and thus sources of calories. There is good evidence for an innate dislike of bitter tastes (31, 120), which are correlated in nature with the presence of toxins. There are also some indications that strongly acid (sour) or irritant substances produce an innate rejection. Again, as with sweetness, although there may be more or less universal biases against these (bitter, sour, irritant) tastes, there is wide variation between individuals and across cultures (71). Judging by the great appeal of animal products cross-culturally and our carnivorous heritage, humans may also have a genetically based tendency to like meat even though it may not be expressed in early life. However, there is no definitive evidence for a genetically influenced preference for or avoidance of meat or of any nonirritant odor.

The second genetically based predisposition is an ambivalent response to potential new foods; a mixture of interest (neophilia) and fear (neophobia) (3b, 94). Biologically, this relates to the possible nutritive value of a potential new food, opposed to the possibility that it will contain toxins. In traditional settings, the interest-fear balance often tilts toward fear, which accounts for a general conservatism in cuisine and preferences.

The third predisposition involves special built-in abilities to alter preferences or likes in response to the delayed consequences of ingestion of a particular food (26, 94). This is particularly clear in the ability to avoid foods that cause illness (acquired taste aversions; 46) but also influences the acquisition of preferences or likings for nutritious foods.

Genetically determined abilities such as these might cause a hypothetical human child, uninfluenced by culture, to choose wisely among foods. Such a claim for the wisdom of the body was supported with a great deal of evidence from studies on rats in the laboratory by Curt Richter (85). Clara Davis (32, 33) carried out a classic demonstration of adaptive self-selection in human infants. She offered three infants, for a period of months to years immediately after weaning, an array of about a dozen foods to choose from at each meal. She reported that the children showed normal growth, even though what they ate was completely under their own control. However, these important findings do not establish a case for the biological wisdom of the body. All the foods offered to the children were of good nutritional value, so that random choice would probably also have led to normal growth. No refined products (e.g. sugar) or flavorings were added to the foods. Most critically, the preferred foods of the infants were milk and fruit, the two sweetest choices available.

Biological factors can explain some individual differences in food choice as well as some universals. There are well-documented, genetically based differences between people in sensitivity to some bitter compounds, and these show a weak relation to preferences for bitter foods. Those individuals with greater sensitivity to bitterness like bitter foods less (44). However, very little of the extensive differences in liking within a culture (74, 74a) can be attributed to genetically based sensory variations. Biological influences on individual variations in preference are probably more often manifested indirectly, as a result of inherited metabolic differences among individuals and ethnic groups (e.g. 56, 115). A case in point is lactose intolerance (114, 115): people carrying this inherited trait usually avoid moderate amounts of milk.

Cultural Factors

The impact of culture on food preference is immense and varied (34, 56, 115; see also 3a). If one were interested in determining as much as possible about an adult's food preferences and could only ask one question, the question should undoubtedly be: "What is your culture or ethnic group?"

Culture has uncoupled the search for food from the ingestion of food, and has greatly extended the number of foods available through agriculture and importation. Traditions regulate the pattern of exposure to foods, the nature of foods, their flavoring and preparation (36, 93). Food takes on nonnutritional significance, perhaps most clearly in India, where the personal history of a particular food (who cooked or touched it) imbues it with social qualities that make it desirable for some and undesirable for others. Food is a medium of social expression in the Indian home, a way of establishing or confirming the social relations and importance of individuals in the family (2).

Individual (Psychological) Factors

There are many differences in food likes among members of the same culture. We know almost nothing about the causes of these differences. Among functioning adults, after our first question (determining a target person's ethnic group or culture), there is no second question that is very informative about food likes. Gender (3, 65, 104) and biological factors such as differences in taste sensitivity account for very little of the variance. What about family influence? When culture is factored out, there are very low correlations (rarely above .30 and often below .15) between likes or preferences of parents and those of their children (16) even when the children are college students (80, 104). Resemblances among siblings are somewhat higher (81). Family resemblances provide an *upper* limit on the possible influence of family environment, since they can also arise from common genetic factors. Most twin studies on food preferences report minimal heritable components (e.g. 43, 50; but see 58 for substantial positive results). If we allow for some genetic effects, the influence of family experiences is even smaller than the low family resemblance correlations indicate.

Two further results add to the puzzlement. Mother-father correlations in preferences or likes are equal to or higher than parent-child correlations (104), and these correlations tend to increase with number of years married (84), which reveals an effect of mutual exposure and influence of the sort we would expect between parents and children. Furthermore, given the reasonable assumption that contact with a parent, especially in a feeding situation, would be the natural vehicle for transmitting likes, it is surprising that mother-child preference correlations are not consistently higher than father-child correlations (e.g. 28, 80, 104, 122). Selection of foods for the family by the food preparer (almost always the mother) may be more influenced by the father's preferences than by the mother's (122).

We presume that much of the unexplained within culture variance can be accounted for by social encounters with people outside the family, particularly peers and respected adults (30), and by the specific individual factors reviewed in the section on mechanisms of acquired likes (see below).

Interaction of Biological and Cultural Factors

Biological and cultural factors establish constraints or predispositions, within which any individual develops a particular set of food likes. But these two types of constraints are not independent. Since culture is ultimately the product of individual humans, some of the biological predispositions we discussed have come to be embodied in cultural institutions (98). A clear example is the cultural evolution of techniques for sweetening foods, including sugar agriculture, refining, and the manufacture of artificial sweeteners, all of which are motivated by our innate liking for sweets (69). Such examples are limited in number (not surprisingly since there are a limited number of biological predispositions), and there are some cases in which cultural forces operate "against" our genetic heritage. Most notable is the culture-induced liking for innately disliked bitter or irritant foods such as coffee or chili (98).

A TAXONOMY OF PREFERENCES AND AVOIDANCES

Liking can be thought of as one of a number of motives for ingestion. A structure of motives underlying food selection was developed for American adults through the use of interviews and questionnaires (41, 100, 101). This analysis suggests that there are three basic types of reasons for accepting or rejecting potential foods. Each of these reasons (Table 1) in one form motivates acceptance, and in its opposite form motivates rejection. This simplified scheme emphasizes the principal feature motivating acceptance or rejection. We review these features below.

Sensory-Affective Motivation

Some items are rejected or accepted primarily because of the degree of pleasantness of the sensory effects in the mouth, or of their odor or appearance. Items accepted on these grounds can be called "good tastes" and those rejected "distastes." The sensory-affective motivation for acceptance is basically equivalent to liking or disliking a food. Individual differences on sensory-affective grounds (e.g. liking or disliking lima beans) probably account for most variations in food preference within a culture.

Anticipated Consequences

Some substances are accepted or rejected primarily because of the anticipated consequences of ingestion. These could be rapid effects, such as nausea or cramps, or the pleasant feeling of satiation. More delayed effects involve beliefs or attitudes about the health value of substances (e.g. they provide vitamins, help one lose weight, contain carcinogens). Anticipated consequences may also be social, such as expected changes in social status as a consequence of eating a food. Foods accepted on the basis of anticipated consequences we label "beneficial," and foods rejected for similar reasons are "dangerous." One may have a distinct like or dislike for the sensory properties of these substances, but if present, this motivation is secondary to anticipated consequences.

Ideational Motivation

Some substances are rejected or accepted primarily because of our knowledge of what they are and where they come from, or for their symbolic meaning. Ideational factors do not commonly play a role in food acceptances, but they do account for many rejections. Two clearly distinct subcategories of primarily ideational rejection can be distinguished.

REJECTION AS INAPPROPRIATE Inappropriate items are considered inedible within the culture and are refused simply on this basis. Grass, sand, and paper are examples in our culture. Typically, there is not a presumption that these items taste bad, and the items are usually considered inoffensive.

Table 1 Psychological categories of acceptance and rejection[a]

	Rejections				Acceptances			
Dimensions	Distaste	Danger	Inappropriate	Disgust	Good Taste	Beneficial	Appropriate	Transvalued
Sensory-affective	−			−	+			+
Anticipated consequences		−				+		
Ideational		?	−	−		?	+	+
Contaminant		−		−				+
Examples	Beer, chili, spinach	Allergy foods, carcinogens	Grass, sand	Feces, insects	Saccharine	Medicines	Ritual foods	Leavings of heroes or deities

[a]Source: Fallon & Rozin (41).

REJECTION AS DISGUSTING Disgusting items are considered offensive, and are rejected both on ideational and sensory-affective grounds. The taste, odor, and/or sight are disliked, and even the thought of eating the item may elicit nausea. Disgusting items are "contaminants" or "pollutants." The possibility of their presence in food, even in the tiniest amounts, makes the food unacceptable (101, 102). A few substances, such as feces, seem to be universally disgusting (1). Within American culture this category includes many animals such as insects and dogs.

Alternative Taxonomies

The taxonomy offered in this review differs from other food taxonomies in that it includes all substances, edible and inedible, acceptable or unacceptable. Other taxonomies provide a finer-grained analysis within the framework of culturally acceptable foods (e.g. 8, 59, 111, 126). In general, flavor emerges as a central determinant of food use, classification, and liking (59, 110, 126, 129). Most of the factors extracted in these studies fall under anticipated consequences, including nutritive and health effects, and social effects (prestige). Two of these studies (8, 126) use a technique that elicits the dimensions that differentiate among foods from each subject, and thereby allows the creation of individualized food taxonomies.

MECHANISMS OF ACQUIRED LIKES AND DISLIKES

In the first years of life, children must learn what is edible and what is not. Since infants and very young children tend to put almost anything in their mouths (33, 106), a basic task of early development is learning what *not* to eat. In this section we focus on adults and children after they have made the basic edible-inedible distinction, and we consider how foods come to be liked or disliked (to have positive or negative sensory properties). The acquisition of likes and dislikes is of special interest in the study of food selection for two reasons. First, it is particularly puzzling. We can understand that someone avoids a food because he has been told it will make him sick, but what makes him come to dislike its taste? Second, from the point of view of public health, it would be highly desirable if people could be induced to like what was good for them, and dislike what was harmful. Acceptance of a food based on liking is particularly stable because the food is then eaten for itself, rather than for some extrinsic reason.

We consider three contrasting pairs of categories (from Table 1). In each case, the first member of the pair involves an affective (like or dislike) response, and the second does not. The contrasts will be: (*a*) distasteful versus dangerous foods, (*b*) good-tasting vs beneficial foods, and (*c*) disgusting vs inappropriate items.

Distasteful versus Dangerous Substances: Learning to Dislike Foods

Many foods that are initially neutral or liked come to be rejected as distasteful or dangerous. When ingestion of a food is followed by some types of malaise, humans (and rats) develop a strong aversion to that food (11, 45, 46, 64, 107). This distaste (called a taste aversion) often occurs after a single negative experience with an interval of some hours between ingestion and illness. There is a tendency to associate novel tastes with the illness. Taste aversions occur even if a person "knows" that the food he has eaten did not cause the illness.

Nausea and vomiting are especially potent as causes of acquired distastes (77). Other negative events such as headache, respiratory distress, hives, and cramps following eating usually induce avoidance motivated by danger rather than distaste. Even the lower gut cramps resulting from moderate levels of milk ingestion by lactose-intolerant people tend to produce a danger-based rejection, rather than a distaste for milk (77). This contrast can be illustrated by typical cases of two individuals who avoid peanuts. One has an allergy to peanuts and suffers rashes and/or difficulty breathing after eating them. This person avoids peanuts as dangerous but likes the taste. If his allergy could be cured he would be delighted to consume peanuts. The other person originally liked peanuts but got sick and vomited after eating them. She dislikes the taste of peanuts, while realizing they are not dangerous.

Individuals report many distastes, yet somewhat less than half of the people surveyed (45, 64, 77) could remember even one instance of a food-nausea experience. We presume that there are other important mechanisms for acquiring distastes, but none have yet been demonstrated. (See discussion below on sensory-specific satiety.)

Good-Tasting versus Beneficial Substances: Learning to Like Foods

There is no single factor that clearly causes acquired likes in the way that nausea causes dislikes. Rather, there is evidence for weak contributions from the factors described below.

MERE EXPOSURE In general, exposure tends to increase liking, and Zajonc (131) has suggested that exposure is a sufficient condition for liking (mere exposure theory). Increased liking for foods with exposure has been demonstrated under controlled conditions for both adults (79) and children (21), with 1 to 20 exposures. There are circumstances under which "mere exposure" produces either no change in preference or decreases in preference (see section on sensory-specific satiety). Whether or not mere exposure is a sufficient condition for increased liking, exposure is surely critical in making it possible for other processes to operate that influence liking.

DISSIPATION OF NEOPHOBIA Exposure may allow fear of a new food to dissipate; one learns that the food is safe (96). For example, Torrance (121) found that liking for buffalo meat (pemmican) increased markedly from first to second exposure, even for those who found it unpleasant on the first exposure. However, it is not clear how dissipation of fear would produce a liking, as opposed to a lack of negative response.

PHYSIOLOGICAL CONSEQUENCES OF INGESTION Rapid satiety may enhance liking (26, 27). Booth and his colleagues offered hungry subjects meals of a high-calorie starch-based food (with flavor A) on some days and a low-calorie food (with flavor B) on other days. After only a few meals of each, hungry subjects showed a relative increase in liking for the flavor of the high-calorie food. However, a flavor associated with a high-calorie food will become *less* liked than a low-calorie flavor if it is consumed when the person is satiated. Unlike the nausea-produced decreases in liking, these changes are state dependent: flavor A paired with high calories in a hungry person is preferred only when the person is in the same hungry state. Insofar as one views rapid satiety as an upper-gastrointestinal "sensation," there is a parallel with the effectiveness of nausea on the negative side.

As with the specific effect of nausea on dislikes, the domain of physiological effects that induce liking is very limited. Oral medicines with distinctive tastes produce positive consequences, such as relief of headache, respiratory distress, heartburn, etc. These medicines are not highly favored as good tastes and there is no special potency of any particular medicinal consequences for enhanced liking. Even the upper-gastrointestinal pain relief produced by antacids is ineffective in promoting liking for their flavor (83).

ASSOCIATION OF A NEUTRAL OBJECT WITH A GOOD TASTE (PAVLOVIAN CONDITIONING) It has been demonstrated that liking for a variety of neutral, nonfood objects can be increased by associating them with positive events (67). In the food domain, sweetness is a convenient unconditioned stimulus, and has been used to produce enhanced preference for flavors on the part of rats (54), children (with chocolate as the unconditioned stimulus; 47), and adult humans. In a recent laboratory study, flavor A was served to young adults in a sweet (palatable) beverage, while flavor B was served equally often in an unsweetened, less palatable form. There was an enhanced liking for flavor A, even when both flavors were served in the unsweetened form (132). Without further research, we cannot evaluate the extent to which associations of this type alter liking or preferences under natural conditions. The acquisition of a liking for coffee may illustrate this mechanism, since at least in early encounters, coffee is usually drunk with a fair amount of sugar. Certainly cultural constraints are operative: for example with most staple foods very sweet tastes are generally rejected by American adults.

SOCIAL VALUATION Animal research indicates that preferences are much harder to establish than aversions (107, 130). Whereas a rat's innate preference for sweetened water can be reversed by one pairing with nausea, it is extremely difficult to produce preferences for innately unpalatable (e.g. bitter or irritant spicy) foods (105, but see 26). The relative weakness of acquired preferences in animals and the great strength of these preferences in humans suggests that some important factors operate only in humans. Sociocultural influences are the obvious candidates.

Social factors probably operate at two levels. First, social pressure (custom, the behavior of elders, the foods made available to the child) forces exposure, which may directly (mere exposure) or indirectly produce liking. Second, the perception that a food is valued by respected others (e.g. parents) may itself be a mechanism for establishment of liking (see 17 for a review).

Children increase their preferences for foods that are presented as preferred by elders, heroes, or peers (39, 66). Birch and her colleagues recently established a role for social influence in a rigorous and convincing way. Nursery school children show stable preference enhancements for foods chosen by their peers (15). Preference for a snack is enhanced if it is given to the child in a positive social context, e.g. used by the teacher as a reward (23, 51). The enhancement must be attributed to a social influence effect (the teacher's indication that she values the food) because if the same food is given to other children, at the same frequency, in a nonsocial context (e.g. left in their locker), there is no enhancement of preference (23). We do not know how social value is conveyed. It could be simply the voluntary use of the food by a respected other, or it could involve verbal or nonverbal (e.g. facial) expressions of positive affect in the respected other.

The importance of the perception of social value in acquired liking is emphasized by the converse phenomenon. A few studies show that liking for a food declines when a child perceives that respected others do not value that food for itself, and that the child (or others) must be bribed to eat it (e.g. rewarded, told how healthy it is). For example, preschool children who were rewarded for eating a particular food showed a drop in preference for that food for weeks after discontinuance of the reward (19; see also 22, 63).

These results are accounted for by self-perception theory (9). People "infer" their attitudes (e.g. liking a food) from their own behavior (e.g. choosing a food). If they ingest a food without clear extrinsic motivation, they tend to justify the behavior by increasing the food's value. However, this relation does not hold if they interpret their behavior as resulting from external causes (e.g. they were forced to eat a food). The decline in value of an object when extrinsic reward is employed is called the "overjustification effect" (62). The fact that people are less likely to come to like oral medicines than foods is consistent with this view, since medicine ingestion is determined by external factors: anticipated beneficial consequences and imposition of use by medical authorities or parents (83).

A relevant study compared a variety of techniques designed to increase adults' liking for grasshoppers (116). The most effective technique used the smallest financial reward and a communicator (person encouraging the ingestion) who was relatively cool and not especially likable. This technique inclines subjects to account for their ingestion of the grasshopper in terms of internal motivation, since external causes were minimal. As the theory predicts, the result is an increase in liking.

Acquired Likes for Initially Unpalatable Substances

Some mechanisms of liking enhancement presume an initial negative response to the food in question. These apply particularly to innately distasteful substances, such as various forms of alcohol, tobacco, coffee, and the irritant spices—in short, some of the more popular ingestants of our species!

Chili pepper, the most widely consumed irritant spice, qualifies as a good taste for almost all users; it is eaten because people like the flavor and mouth "burn" it produces. This shift from dislike to like happens by age 5–8 years in many chili-eating cultures (108). The shift could result from some of the mechanisms outlined above (e.g. pairing with rapid satiety, social valuation) (95, 108) or from either of the special mechanisms discussed below, which may also account for the shift to liking for other initially unpalatable items.

CONSTRAINED RISK The mouth pain produced by chili may become pleasant as people realize that it does not cause harm. Liking for chili pepper may be a form of thrill-seeking (or "benign masochism"), in the same sense that the initial terror of a roller coaster ride or parachute jumping is replaced by pleasure. People come to enjoy the fact that their bodies are signaling danger but their minds know there really is none (108).

OPPONENT RESPONSES The many painful mouth experiences produced by chili in the novice eater may cause the brain to attempt to modulate the pain by secreting endogenous opiates (morphine-like substances produced in the brain). There is evidence that, like morphine, these brain opiates do reduce pain. At high levels, they might produce pleasure. In accordance with opponent process theory (118), hundreds of experiences of chili-based mouth pain may cause larger and larger brain opiate responses, resulting in a net pleasure response after many trials (99).

Disgusting versus Inappropriate Substances

Why do disgusting items, primarily of animal origin (1), come to be offensive and disliked, while inappropriate items (primarily of vegetable or mineral nature) are treated as neutral? Three features of disgust seem to be universal: a characteristic facial expression, the inclusion of feces in the disgust category, and the fact that disgusting items serve as psychological contaminants (rendering otherwise good food undesirable after the slightest contact with the disgusting item) (1, 40, 102).

There is no evidence for an innate basis for disgust: infants do not manifest an aversion to feces, and decay odor does not seem to be innately aversive (78). Children in the United States do not develop the contamination response to disgusting objects until the first years of elementary school (42). We presume that the offensiveness of disgusting items is somehow conveyed to children by their parents, perhaps through facial and other forms of emotional expression. It seems reasonable that feces produce developmentally the first disgust, and that this arises through the process of toilet training, but there is no firm evidence on this point (101, 102), nor on the general issue of how ideas about the nature or origin of a substance lead to such powerful emotional responses to it. In contrast, children probably learn to avoid inappropriate items by being informed, in a more neutral emotional context, that such items are inedible.

Summary and Evaluation

At this time, our list of mechanisms that lead to acquired likes and dislikes is incomplete. It is difficult to assign particular foods to particular mechanisms, partly because many substances are consumed for multiple reasons (111). People drink coffee because of the pleasant oral sensations, the positive pharmacological effects, to avoid withdrawal, to be social, to avoid eating, and/or out of habit (49). Individuals have multiple motivations, and the pattern of motives varies from one individual to another. Furthermore, ingestion of the same food at different times may have different motivations, as when someone drinks coffee in the morning to wake up and in the afternoon to be social. In this respect, chili pepper is simpler than coffee, since the motivation for consuming chili pepper is predominantly oral pleasure (98, 108).

It is essential to distinguish the current motivation for acceptance of a food from the historical cause of that acceptance. A typical chili pepper user is motivated by sensory pleasure, but his enjoyment may have come about through social valuation and physiological effects. The taxonomy we have presented deals with current motivations, but these same motivations constitute the set of causes of acquired changes in liking.

THE TIME FRAME: LABILE AND STABLE LIKES

So far, we have emphasized the stability of preferences and likes. However, a person's liking for a particular food will vary with a number of factors, including the time of day, physiological state, recent past eating experience, and the context in which the food is presented. Many of these factors are subject to cultural influences. Some of them result in temporary, reversible changes in liking, and some in more permanent changes. In addition, whereas some of these factors influence likes for broad classes of foods, others result in a very specific change restricted to a particular food.

The Influence of Physiological State on Likes

The physiological state of the organism is one factor that influences how much foods are liked (29). Organisms in a nutritionally deprived state will find almost *all* food more attractive than when they are not deprived. Cabanac has investigated this overall change in the perceived pleasantness of foods, termed *alliesthesia,* by observing changes in pleasantness ratings for sucrose solutions by initially hungry subjects who subsequently consume either nothing or a substantial amount of sucrose. Subjects ingesting sugar solutions showed a decline in their pleasantness rating of the solution over time whereas those without this caloric load showed no change in pleasantness rating.

Cabanac believes that sensory pleasure plays a homeostatic role, reflecting internal need states. Taste and olfaction, with their special involvement with food, should be closely linked to nutritional state. Thus, the liking for odors should change as a function of nutritive state. Accordingly, it has been found that manipulation of nutritional need influences the pleasantness of food odors but not of other odors (38). However, the assumption that nutritional state is the key variable has been questioned by observations of equivalent changes in pleasantness rating after ingestion of nonnutritive substances (125).

Physiological state (energy balance) also alters liking for particular foods in relation to their power to satiate. Booth and his colleagues (27) offered energy-deprived subjects separate meals of high- and low-calorie foods, with similar sensory characteristics, except that each type was marked with a different, arbitrary flavor. Over a series of meals, subjects learned the consequences for satiety of eating each of the foods (and associated flavors) offered. Subjects subsequently preferred the flavor of the high-calorie food when energy deprived, but the flavor of the low-calorie food when replete. Thus, liking for a particular food depends upon an interaction between the person's current physiological state (full or hungry) and past experience with the food in question.

There is abundant evidence that animal preferences for particular nutrients are affected by the availability of these nutrients in the body (85, 94). Evidence in humans is less extensive; the best comes from indications that human sodium preference is related to sodium deficiency and/or dietary sodium levels (7). Human preferences for high-carbohydrate versus high-protein foods may also be related to a specific physiological variable. Recent work on animals and humans by Blundell (24, 25), Wurtman (128), and their collaborators indicates that high brain levels of the neurotransmitter serotonin induce a relative preference for protein as opposed to carbohydrates. These findings are of particular interest because brain serotonin levels are influenced by serotonin precursors in the diet (127). It is possible that changes in protein/carbohydrate preferences in the course of meals may be related to changes in serotonin levels (25).

Temporary Changes in Likes: Sensory-Specific Satiety

Le Magnen (61) observed that rats offered successive meals containing the same food but with varying odorants consumed more than rats offered a single-odorant food combination. He named this phenomenon "sensory-specific satiety" because the foods differed only in their chemosensory properties.

Sensory-specific satiety effects on consumption have been reliably observed in humans (82, 89–91), including children (20). Such effects are measured as a decrease in total consumption as the number of choices decreases, or as a drop in hedonic ratings of a food consumed repeatedly. For instance, subjects offered a variety of hot hors d'oeuvres, all at one time, ate more than subjects offered equal amounts of only their single favorite hors d'oeuvre (82). Variety in a meal resulting from multiple, successive courses also stimulates increased intake.

Most research on sensory-specific satiety in humans has been carried out by Rolls and her collaborators (see 88 for review), using this sequential food paradigm: Subjects offered four different courses (crackers with different spreads, different sandwiches, or yogurts differing in visual appearance, texture, and taste) eat more in the varied meal condition than they eat of their favorite food alone, presented over the same period of time (89, 91). The increase in consumption in the varied condition is large and seems to vary with the similarity of the different foods. For example, in the varied condition, sandwiches with fillings that differ in appearance, taste, and texture stimulate 33% greater intake, whereas yogurts, differing less in taste but more in appearance, stimulate 19.5% more consumption (90).

In humans, the change in liking accompanying the sensory-specific satiety effect on consumption can be assessed. A food that is eaten declines in liking relative to foods that have not been eaten (82, 90). In one experiment, subjects taste and rate seven different foods, one of which is subsequently eaten to satiety. The subjects show declines in liking for the eaten but not the uneaten foods immediately after eating and these changes remain stable over twenty minutes (89). The magnitude of changes in liking is greatest immediately after eating and then gradually declines over the course of an hour (88).

The time course suggests that the foods eaten diminish in pleasantness before they can exert postingestive effects. Further, since the pleasantness ratings do not continue to decrease with increased time for postingestive consequences, these ratings appear to be insensitive to the metabolic consequences of food consumption. Additional evidence suggesting the relatively minor role of nutritive consequences on changes in likes is the observation that the same magnitude of changes in liking occurs over the course of a low- or high-caloric meal (88). The changes in pleasantness correlate positively with consumption in a subsequent course (89). Thus, if sausage is eaten in one course, there will be a large drop in the pleasantness between pre- and post-ratings, a drop that predicts how much sausage the subject would eat if offered more.

The mechanism underlying the selective decrease in hedonic evaluation (liking) and consumption awaits further investigation. Neither alliesthesia (29) nor sensory adaptation (88) can account for the magnitude and specificity of sensory-specific satiety. One possibility meriting further exploration is that cognitive factors play a role. The pleasantness of a food may decrease according to the memory for how much of a food has been consumed.

Relatively Stable Changes in Likes: Monotony

The effect of frequent repetitions of the same foods has been examined in army personnel (112). Rotation of only four daily menus over a five-week period led to a drop in hedonic ratings of meats and vegetables, but not of other foods. A subsequent study exposed university students to an alternation of only two daily menus (lunch and dinner) for up to six weeks (113). This treatment led to a decline in hedonic ratings for all types of foods served. The decreased liking persisted, with only minor improvement, at a retest four months after completion of the study. The decline in liking was *least* for the best-liked foods and, as in the first study, there was a tendency for main-dish items to decline most in liking.

The sensory-specific satiety, monotony, and mere exposure paradigms are essentially identical: in each case, the same foods are repeatedly consumed with no particular consequences. The result is either a decrease or increase in preference. On the basis of the data on food and other research on exposure effects (10, 52, 131) it seems that exposure is more likely to enhance liking when it occurs at moderate frequency, and when the stimuli are novel, relatively complex, or both. For many novel items, there may be enhanced liking at moderate levels of exposure, followed by decreased liking when exposure becomes more frequent. Decreased preference effects (e.g. sensory-specific satiety; see also 119) may in general be more transient, perhaps because they are often produced by a close bunching of experiences. Finally, the monotony studies suggest that how much a food is liked in the first place, as well as the particular kind of food it is, may affect its susceptibility to overexposure.

The Influence of Context on Likes

A judgment about foods and flavors is, of necessity, made in a particular context. The context includes social setting, ideas of appropriateness, expectations, and, at the most elementary level, the foods accompanying and preceding the food in question. A meal can be described as a temporal sequence of complex flavor and texture experiences. Clearly, a momentary rating of strength of sensation or of liking will be strongly tied to this context.

The effect of context on food perception and evaluation has been studied in the laboratory, albeit under very simple conditions: only one flavor is experienced, and the context consists of recent prior experience with that flavor in different intensities. The question addressed is, how will the perception or evaluation of a standard flavor be influenced by prior exposure to relatively stronger or weaker instances of that flavor?

Psychophysical research in domains other than taste and smell demonstrates the potent influence of the intensity of prior experiences (context) on current sensory/perceptual (53, 76) and hedonic evaluations (109). Parducci (76) has shown that, in general, judgments are a function of both the range of stimuli perceived and the frequency of exemplars of each type. These principles of sensory/perceptual evaluation have been demonstrated by a number of investigators for both tastes and flavors.

The dependence of intensity evaluations on context is illustrated by the following manipulation of salt in soups (60). Subjects experienced salt in two different contexts—one high-salt and one low-salt—in two separate sessions. In each context they received three levels of salt, with the middle level appearing in both sessions. Subjects in the high-salt context (0.25, 0.35, 0.50 M NaCl) rated 0.25-M NaCl soup as less salty than subjects in the low-salt context (0.12, 0.18, 0.25 M NaCl). Similar effects were observed in other studies in which subjects evaluated the saltiness and pleasantness of soups (86).

Riskey et al (87) found that the *hedonic* evaluation of tastes and flavors follows the same contextual principles as evaluation of sensory/perceptual properties. Generally, people seem to prefer sugar concentrations in the middle of the range of rated sweetness (87).

The context effect does not seem to depend on a particular evaluation method. It has been demonstrated with category rating scales, magnitude estimation, method of comparison, and a mixing method (e.g. diluting a strong sample) (48, 60, 68, 86, 87). Peripheral sensory alterations cannot account for the effects. Although manipulations affecting sensory adaptation (e.g. rinsing, delays) alter the intensity of ratings (e.g. for saltiness in soups), they do not affect the magnitude of the context effect.

The short-term influences on food likes observed in these experimental studies could result from perceptual changes (changes in the perceived intensity of a beverage would affect one's evaluation of the beverage). The prior exposures that are part of these studies may also influence evaluation directly. For these temporal context effects to operate in normal food choice, outside the confines of a single meal, the context effects would have to endure for days, weeks, or longer. That this may indeed be the case is suggested by the observation that some subjects maintained for an extended period of time on a low-salt diet rate a given sample as more salty than they did before beginning the diet. They also show a shift in preference to lower salt concentrations, which may follow from the change in perceived intensity (12).

Context also includes attitudes about the appropriateness of particular combinations of foods and the appropriate time to consume foods. These contextual effects are heavily influenced by culture. For example, although Chinese prefer a lower level of sweetness in a beverage relative to North Americans, they prefer a higher level of sweetness in their crackers (13). Pangborn (73–75) has consistently emphasized the importance of simultaneous context in judgments of both intensity and pleasantness. Predictions about liking of salt or sugar in a particular medium (e.g. juice or soup) cannot be made on the basis of pleasantness ratings of NaCl or sucrose in water. For example, American adults find salt at moderate levels pleasant in soup but unpleasant in water (7), and preferred levels of sweetness in dairy products depend on the level of fat (37).

Other, more general cultural rules of appropriateness of foods have major effects on acceptability. Among Americans (even as young as three years of age), certain foods are more or less desirable for breakfast than for dinner (18). Some contextual attitudes are not acquired until later in childhood. For example, in American culture, certain combinations (e.g. meat and potatoes) are acceptable and others (e.g. hamburger and ice cream) are not. For adults, this attitude is somewhat independent of how much they like the component foods. Children under six years of age, however, unlike adults, appear to follow the rule that if they like both A and B, then they will like the combination of A and B (42, 103), even if A and B are hamburger and whipped cream.

CONCLUSIONS

We are just beginning to understand the origins of food likes and dislikes. The complex multidetermination of likes and the massive role of culture have discouraged intensive investigation. But food likes and dislikes are such a powerful force in nutrition that they must be a focus for future research.

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