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Adaptiveness of food learning and food aversions in children

Abstract. *This paper uses an evolutionary perspective to explain features of food learning in human children. Data from Western parents indicate that (1) children are least picky about foods when they are between one and two years of age, (2) vegetables are frequently refused by children, and (3) children have a tendency to eat foods one at a time rather than mixed together. Adaptive explanations for these patterns are suggested, together with supporting evidence from studies of the ontogeny of human and non-human primate diet choice. The following arguments are made: (1) age difference in receptiveness to new foods is consistent with the existence of a sensitive period for learning about food; (2) since leaves and other non-fruit plant parts often contain toxic secondary compounds and young animals are less able to detoxify these chemicals than are adults, an initial dislike of vegetables may function to protect young children against the risk of poisoning; (3) a preference for easily identifiable foods eaten separately may be an evolved preference that aids in identification of the food and the consequences of eating it.*

Key words. *Adaptation – Childhood – Diet – Food – Aversions – Food learning*

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The world is full of treacherous living things masquerading as possible foods. How does a child learn to tell which things are worth eating and which are not? Food choice is clearly an aspect of behavior with strong selective consequences. Since the pioneering work of Garcia (Garcia and Koelling, 1966; Garcia et al., 1968) on taste aversion learning, it has been recognized that rats and other animals (including people) can readily learn to associate the taste of ingested food with subsequent nausea, even after a long time interval, whereas rats, at least, are unable to associate taste with a reinforcer that would not naturally be paired with it, such as electric shock. The selective advantage of this type of "biased learning" seems obvious, and few today would doubt that it represents an evolved adaptation.

Despite this, the literature on food learning in children has tended to view children's food habits and aversions as problems to be solved rather than potentially adaptive behaviors to be explained. Eating habits, particularly among toddlers, are a common source of parental concern. Parents often worry about the narrowness of their child's diet, and about their child's refusal to eat specific foods. This paper does not suggest ways to solve these problems. Rather, it suggests explanations for why these food habits exist, and reviews evidence from a variety of fields to support these arguments. Cultural implications of these behaviors are also considered.

Is there a sensitive period for learning about food?

Culture plays a powerful role in distinguishing substances accepted as edible from those rejected as non-edible (de Garine, 1978; Simoons, 1994), and foods deemed acceptable are an important aspect of ethnic identity (Brown and Mussell, 1984; Douglas, 1984; Fischler, 1988). Food preferences and taboos serve as potent ethnic markers since an inability to eat with others virtually precludes social interaction with them. Yet the cultural durability of food preferences and aversions is puzzling. Long after a group is acculturated in dress and other aspects of behavior, signals of cultural identity remain at the dinner table (Rozin, 1976: 300–1; Birch, 1987: 121; McKenzie, 1967). Why should food habits be more conservative than other aspects of culture?

A hint can be found in the deep-seated feelings of aversion and often disgust a person feels when faced with something his culture has told him is "not food". A person brought up in a kosher household can easily adopt the dress of his gentile neighbors, but sharing a shrimp cocktail with them would be likely to make him feel physically repulsed. Because of this, food is a highly honest signal of ethnic affiliation – dietary norms are difficult to fake – as well as a highly durable one.

The durability of cultural norms about food may stem from the existence of a sensitive period for learning which foods are acceptable and which foods are not. A sensitive period is a part of the lifespan during which proper development depends upon the presence of appropriate stimuli; outside of this developmental window it is difficult to learn new things and unlearn old ones. Anything learned (or not learned) during a sensitive period, therefore, would be difficult to change in adulthood, and would consequently serve as an honest signal of one's cultural affiliation. Language obviously is one such behavior; food acceptability may be another.

A sensitive period for learning about food may make adaptive sense, given the high costs of eating unpalatable items. Since the benefits associated with continued experimentation would decline after a child became exposed to the normal range of foods in its environment (i.e. after one or two seasonal cycles) whereas the costs of such experimentation would remain high, it might make sense to restrict open experimentation to the very early years, particularly since the child will be protected by its parents during this period.

There is a common assumption that infants will put anything into their mouths whereas older toddlers are often picky eaters; this is what we might expect if food acceptability were learned chiefly in the first two to three years of life. This assumption is based on little systematic data, however. In an effort to measure age changes in food receptivity that might support the argument of a sensitive period for food learning, I asked a sample of American parents to recall and answer questions about their children's eating behavior at different ages. The 129 children in the sample were of different ages, with the largest number being either 5 ($n = 36$) or 10 ($n = 39$) years old.[1] These data have been reported elsewhere (Cashdan, 1994) and the results will simply be summarized here. Parents were asked to rate their child's behavior at different ages on a 5-point scale, from 1 ("refused nearly all foods offered") through 3 ("ate some foods offered") to 5 ("ate nearly all foods offered"). Figure 1 shows how children's willingness to try foods changes between the ages of 6 months and 5 years. The children in my sample were most receptive between the ages of one and two.

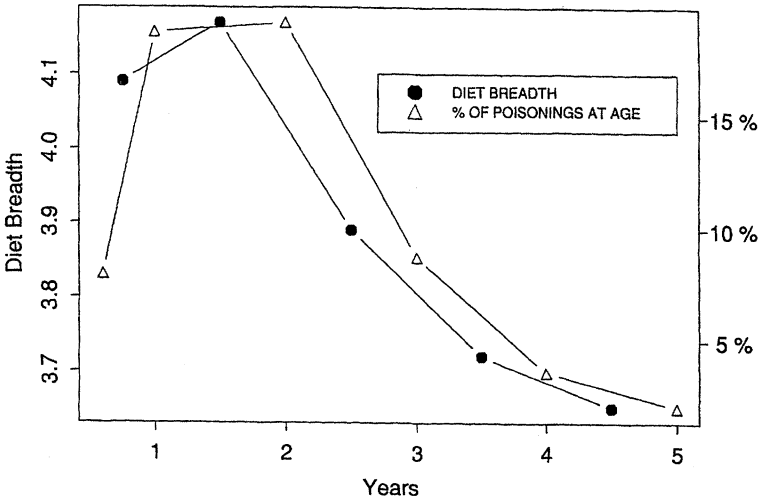

FIGURE 1
Changes in diet breadth and poisoning rates with age

Legend: The first diet breadth point indicates average diet breadth between 6 months and 1 year, the second point between 1 and 2 years, and so on. The data on poisoning rates indicate the percent of total reported poisonings that occurred at each age (number poisoned at age x divided by total poisonings reported, ×100), and are based on data from all US poison control centers in 1990.

Source: Figure taken from E. Cashdan, "A Sensitive Period for Learning about Food", *Human Nature*, 5 (3) 279–91, copyright 1994 Walter de Gruyter, New York. Used with permission.

Food receptivity dropped significantly in the 2–3 year age period ($p = .0004$, Wilcoxon matched-pairs signed-ranks test) and dropped again, by a smaller but still significant amount ($p = .009$), between 3 and 4 years. These changes are similar to age changes in the frequency of accidental poisonings (see Figure 1), and may reflect the same underlying phenomenon (see Birch, 1987: 114).

Finickiness and neophobia about food are highly correlated (Pelchat and Pliner, 1986), and there has been a growing interest in the latter phenomenon in recent years. Although the data are not completely consistent, taken together they suggest a pattern of minimal neophobia and finickiness during the first two years, an increase over the next three years, and then a gradual decline from about age five or six through adulthood. In children younger than two, the literature suggests that neophobia is rare or nonexistent. In a variety of cultures children under two years of age are reportedly more willing than adults to try new foods, and they readily consume items that adults in the culture find disgusting (Simoons, 1994: 322–3). French children also do not appear to be neophobic about food until after the age of two (Fischler, 1988). Fischler and Chiva (1985: 148) found that about 40 percent of the mothers they interviewed spontaneously mentioned a clear change in the child's behavior and attitude toward food at some age between two and four, citing as a typical remark "at the beginning, there never used to be any problem. But now that she's bigger, she's turned very particular". Preference changes may also be easiest to induce in children younger than three years of age (see Birch, 1987: 114–15, 122 and review in Cashdan, 1994). The picture from the literature is least clear for the period between two and five. By age two or three children in Sweden (Koivisto and Sjoden, 1996) and the US (Birch, 1990; Harper and Sanders, 1975; Pelchat and Pliner, 1986) show evidence of neophobia, but evidence of age changes between two and five is inconsistent. Most studies reporting age differences in neophobia concern children older than five years, and in this age bracket the younger children are often reported to be more neophobic (Hursti and Sjoden, 1997; Pliner and Loewen, 1997) and finicky (Fischler and Chiva, 1986) than adolescents and adults.[2]

It is clear, however, that food neophobia among adults remains significant. Exposure and social factors are known to increase preference for items already accepted as edible, but items that are classified as "not food" are often viewed with disgust and may be refused even if it is clear that they are edible and there are incentives to eat them (Peryam, 1963; Farb and Armelagos, 1980: 27).

Research among a wide variety of species shows that early food experiences can have a persistent effect on later diet choice, but most of these studies do not provide clear evidence of a sensitive period. There are some exceptions, however. Studies of sheep show not only that foraging experiences early in life have a greater effect on adult diet than similar experiences later in life, but that younger animals are more willing than older ones to accept novel foods (Provenza, 1994). Weanling rats do not show neophobia when they are first exposed to a flavor, whereas young adult rats do (Misanin et al., 1983; Misanin et al., 1985). And young infant gorillas sample novel foods more frequently than do older infants, who in turn sample such foods more frequently than do juveniles

(Watts, 1985). It would be reasonable to expect such a pattern wherever the likelihood of encountering new food types decreases after the juvenile period and the cost of feeding errors remains high.

Why don't children like vegetables?

While conducting the study discussed above, I also asked parents about specific food dislikes. These data have not been reported before, and they open further questions that will be addressed in the remaining sections of the paper. Parents were asked to list the foods their child refused to eat and the age of first refusal and whether the child had previously enjoyed the item. Of the 277 foods mentioned (number of children = 129), nearly half (46%) were vegetables whereas only 8 percent were fruits. The category "vegetable" is used here in the usual culinary way, to include leaves (e.g. spinach), stems (e.g. broccoli), and roots (e.g. carrots), as well as items that are usually thought of as vegetables but are botanically classified as fruits (e.g. cucumbers). Culinary fruits differ from vegetables in undergoing the change in composition as they mature that we call ripening; this is a signal from the plant that its seeds are mature and the flesh of its fruit is sweet and wholesome. Other plant parts change with maturity also, but unlike fruits they become tougher and less edible as they do so (McGee, 1984).

Children's dislike of vegetables, particularly greens, is not a novel observation (Eppright et al., 1969; Hertzler, 1983; Fischler and Chiva, 1985 and references therein) and a number of researchers have offered suggestions for enhancing children's preferences for these valuable foods (Alford and Tibbets, 1971; Ireton and Guthrie, 1972). It is, however, puzzling: if these foods are so nutritious, why should children dislike them? Shouldn't natural selection have favored individuals who have a preference for nutritious foods?

Toxic secondary compounds are found in many plants, where they function as a defense against herbivores (Crawley, 1983; Rosenthal and Janzen, 1979; Whittaker and Feeny, 1971). Such toxins have been shown to affect the dietary preferences of a variety of primate species (reviewed in Glander, 1982). Plant toxins pose a significant risk to human children as well, particularly very young children. Among 6–18-month-old children who come to the attention of the Utah Poison Control Center, houseplants are the single greatest cause of poisonings (Joseph Veltri, Utah Poison Control

Center director, personal communication 1992). It is striking that plants remain a significant source of poisonings, in view of the many other sources of poison in the urban child's environment. In the environment of our foraging ancestors, the risk of being poisoned by such toxins would surely have been greater.

An innate caution toward potentially toxic plant parts is especially important for young animals, not only because they are less knowledgeable about foods but because they are less able than older animals to detoxify large amounts of plant toxins. Toxic secondary compounds are diverse – there are more than 5000 known alkaloids alone (Levin and York, 1978) – and the enzymes used by animals to detoxify these chemicals are initially present in low concentrations. With subsequent exposure, the amount of the enzyme appropriate to a particular chemical increases (Freeland and Janzen, 1974). Young rats, accordingly, cannot detoxify foreign chemicals as well as mature rats (Freeland and Janzen, 1974) and the same is probably true for young humans.

Young children's negative response to "vegetables", therefore, may be an evolved adaptation that reduces the risk of exposure to plant toxins. Data from primatology lend support to this hypothesis. Some caution is in order when making this comparison, since monkeys are better able to detoxify foods physiologically whereas humans can compensate by detoxification through cooking. Nonetheless, both physiological and cultural mechanisms are costly, and neither works perfectly. Caution and reliance on social learning might still be expected.

Howlers (*Alouatta palliata*) are a useful species for comparison since their digestive systems are less specialized than those of other leaf-eating monkeys (albeit far more so than those of humans), hence they probably do not obtain the same level of detoxifying benefits from gut flora that these other monkeys do (Milton, 1978a; Milton, 1978b). In his study of howler monkey diets, Whitehead (1984) found toxins in many plant species in the monkeys' environment; even edible species have toxic leaves during certain seasons of the year. These leaves are avoided by adult monkeys (Whitehead, 1984; Glander, 1978). Fruits are also an important part of the howler monkeys' diet but do not hold as great a danger, presumably because fruits are "designed" by the plant to be eaten.

Whitehead's comparison of leaf and fruit learning in young howler monkeys shows that food-learning strategies are related to the likelihood of suffering ill effects from plant toxins. Infant howlers learn about leaves through very careful social learning: when eating leaves, they eat only after the mother does, copying her closely and eating only leaves from the same branch. However, infant howlers are much less reticent when eating fruits, and individual learning appears to play a greater role: the infants often eat before their mothers do, are less likely to attend to adults when eating fruits, and do not limit their feeding to the same branches as their mothers.

Chimpanzees face a similar danger from plant toxins. Mahale chimpanzee mothers have been observed pulling the hands of their infants away from toxic leaves, and the diet of the youngsters contains a smaller percentage of mature leaves than does the diet of their mothers. As Hiraiwa-Hasegawa (1990: 282) notes, "many plants contain secondary compounds as a defense against leaf-predators, particularly in mature leaves . . . The relatively small portion of the infant diet that consisted of mature leaves of trees suggests that infants may be inefficient in detoxifying such compounds."

Caution when eating leaves and other potentially toxic plant parts, and the importance of social learning when doing so, should be equally adaptive for young humans. Like young howler monkeys and chimpanzees, human children must learn which leaves and other plant parts are edible ("vegetables") and which are not.

An alternative (but related) explanation for the aversion to vegetables is that the food value of vegetables is typically low in comparison to fruits and animal products. Milton (1979) has shown that the preference among howler monkeys for young rather than mature leaves is due chiefly to the young leaves' higher protein and lower fiber content. A similar concern can also be expected to motivate diet choice among humans, especially human children. In general, small-bodied animals require higher quality diets than large-bodied animals (Gaulin, 1979; Milton, 1979). A diet with a high ratio of calories or protein to fiber may be especially adaptive for human children, therefore, particularly when they are growing rapidly.

These two factors undoubtedly interact in determining the net benefit of foods, and it may be impossible to consider one without the other. As Janzen (1978: 77) has pointed out, "'Toxicity' can only be operationally defined as that case where the energy and resources expended are greater than the return in usable materials. . . . Toxicity thus becomes defined as an outcome and is not an inherent property of any chemical." By this definition, then, "the seed is not toxic, but the leaf is, and yet they [may] have the same secondary compound concentration" (Janzen, 1978: 77). Even a vegetable low in toxins, therefore, might be considered relatively toxic by this definition if it also provides few calories or other nutritional benefits.

Comparing the food and medicinal use of wild fruits and other plant parts is instructive in this regard, since the secondary compounds that make plants toxic as food are sometimes used deliberately as medicine by people (Johns, 1990 and references therein) and other primates (Glander, 1994 and references therein). Table 1 presents some previously unpublished data that I collected in the Kalahari Desert in 1979; it indicates which wild plant parts are used for food and which for medicine.[3]

The data show that fruits, which are high in food value and (when ripe) low in toxins, are the part most often used for food. Bark, on the other hand, low in food value but often high in toxins, is frequently used for medicine but never for food. The various "vegetable" parts fall somewhere in between, with roots being used frequently for medicinal purposes in this area. This has been found elsewhere as well (the Hmong in Thailand, Pake, 1987), although leaves and bark exceed roots as medicines in some other areas (Telban, 1988).

TABLE 1
Plants parts used for food and medicine in the Kalahari

Plant part	*% of plant foods*	*% of plant medicines*
Fruit	36	5
Seed	3	0
Nut	3	1
Bean	7	0
Root/tuber	17	75
Leaf	14	8
Sap	19	2
Bark/branches	0	8
Total	99%	99%

Note: Percents based on 58 plants used for food, 84 for medicine.

Roots are a somewhat anomalous category from the point of view of child preferences also. Data from a pilot study I conducted in 1997 suggest that roots from some species are among the foods most preferred by young Bushman children while roots from other species are among the most disliked. None of the mothers in my American sample mentioned potatoes as a food disliked by their children; indeed, Westerners apparently do not even consider potatoes to be a vegetable (Fischler and Chiva, 1986). The anomaly is probably due to the high caloric value of root vegetables. Root crops are important food staples among horticulturalists in many parts of the world, but frequently must be detoxified before consumption (Johns, 1990). The number of root medicines in my sample is nonetheless surprising, since leaves are also high in secondary compounds. Perhaps humans have evolved better physiological defenses to the secondary compounds in leaves, since roots and tubers are more difficult to exploit.

The adaptive explanation suggested here is not, of course, inconsistent with more proximate explanations about the reasons for children's dislike of vegetables. At a proximate level, children probably don't like vegetables because they don't like the way they taste (alkaloids frequently taste bitter). The argument given here does not dispute this, but suggests an evolutionary reason for this preference.

Neither should the argument be taken to mean that a permanent distaste for vegetables is somehow innate. There is abundant evidence that "mere exposure" can increase preference for foods (Birch and Marlin, 1982; Maslow, 1937; Pliner, 1982), that children's preferences for particular vegetables are strongly correlated with familiarity (Alford and Tibbets, 1971; Phillips and Kolasa, 1980), and that vegetables are liked more by people over the age of 18 years (Logue et al., 1988). These findings suggest that children will gradually come to like the foods – including vegetables – that they are taught are appropriate to eat.[4]

An increase in preference for vegetables is to be expected, both because an individual should be better able to detoxify the chemicals in a plant as his or her body gains exposure to it and because he or she can have greater confidence in the safety of a plant eaten safely many times before. As with the howler monkeys, therefore, this phenomenon may be best interpreted as an innate caution toward vegetables, with preference and consumption highly dependent on social learning.

Many primates (Cambefort, 1981; Hauser, 1993) and other species (Galef, 1988; Galef et al., 1994) learn about foods through imitation and other forms of social learning. Because humans have a more limited physiological adaptation to plant toxins than most other primates, social learning should be, if anything, even more important among humans. The arguments given above, which suggest that natural selection has shaped the development of social learning about different types of food, are consistent with the obviously important role of culture in determining cross-cultural dietary differences.

Why don't children like mixed foods?

Some of the foods that were refused by children in my sample share the characteristic that they involve modes of food preparation that obscure the identity of particular food items. These include saucy and mixed foods (8 percent of the 277 foods mentioned) and pureed items (3%). As one of the mothers explained, her child "likes foods where all of the ingredients are without sauce and easily identified".

This response was so frequent that I asked a sub-set of my sample ($n = 63$) "does your child prefer to eat different foods mixed up together (casseroles, foods with sauces, etc.), or does (s)he prefer to eat each item separately?". Parents were asked to report their child's preferences in this regard, and the child's preference when a toddler. About half (52%) of these children were reported to have preferred foods that were not mixed together when they were toddlers, and nearly all the rest (44%) had no preference. Only two (3%) preferred mixed foods. A similar pattern was reported for the children's current behavior. A preference for plain and unmixed foods has also been noted by other researchers (Lowenberg, 1948) although the data are not unambiguous (Hertzler, 1983).

The behavior of the infants in Davis's classic study of food choice (Davis, 1928) may reflect the same phenomenon. Among her infants, who were allowed to select their own food from a wide array of choices, "a tendency was observed in all the infants to eat certain foods in waves. . . In the diet kitchen such waves came to be known as 'egg jags', 'meat jags', 'cereal jags', etc." (Davis, 1928: 670–1). Her findings suggest that the tendency to focus on one food at a time may exist from infancy.

How can this behavior be explained? It is possible that a preference for easily identified foods, eaten separately, enhances the process of food learning. In order to learn which items in the environment are appropriate to eat and which are not, an individual needs to be able to identify the item. Sauces, purees, casseroles, and other mixed prepared foods obscure a food's identity. (The reported preference for raw as opposed to cooked vegetables [cf. discussion and references in Hertzler, 1983] may reflect the same phenomenon, since raw vegetables typically have more distinctive textural cues than cooked ones.)

In addition to being able to recognize the food item, an individual learning about food needs to be able to identify the source of discomfort if an item consumed makes him or her sick. This can be done most easily if one food type is eaten at a time. Rozin (1969; but see Galef and Beck, 1990) has suggested that this is the reason rats, particularly those that are nutrient-deficient, sample one food at a time when faced with a choice of multiple foods. While these preferences can be infuriating to a parent, therefore, they may be aspects of an evolved strategy that makes food learning easier.

While many toddlers reportedly had a preference for eating one type of food at a time, this preference may become even stronger among slightly older children. Of the 31 "mixed/saucy/pureed" foods that children in my sample refused to eat, nearly all were accepted when they were first offered, and were rejected only later (only 8 percent were rejected at first introduction). These foods were first introduced at an average age of 1.9 years (with a mode of 2 years). However, they were not rejected until 4.5 years, on the average (with a mode of 4 years). This was not the case with vegetables or other types of rejected foods, which were frequently rejected the first time they were offered (initial rejection was 55 percent for vegetables, 39 percent for other foods).

It is not obvious why an aversion to mixed saucy foods should harden at this age. The phenomenon may be related to the development of feelings of disgust at the thought of ingesting certain substances, an emotion which is not found in very young children (Rozin et al., 1986a; Rozin et al., 1986b; Fallon et al., 1984). One characteristic of items that engender disgust, according to Rozin and his colleagues, is the feeling that even a tiny amount of a disgusting substance is contaminating and renders a formerly acceptable item unacceptable. Some of the children in my sample expressed what appears to be a concern with contamination when two foods come into contact, even when each food is otherwise acceptable; for example, one mother reported that her child insisted on using different utensils for each type of food.

It is likely that any animal would find it adaptive not to eat more than one novel food at a time, so that the source of any ill effects could be identified and avoided in future. The problem of masking the identity of food with sauces and other complex forms of food preparation, however, is uniquely human, as is the notion of contamination, which underlies many of the highly elaborated dietary proscriptions found in various cultures of the world (Douglas, 1966). A full explanation of this aspect of children's food behavior will be a challenge for the human sciences.

Implications for future research

The findings reported here have been given an evolutionary interpretation, but the data are limited and the explanations speculative. The empirical findings will require support from both behavioral and cross-cultural data. It would be interesting to know, for example, whether the age difference in the preference for fruits over vegetables found in western societies (Logue et al., 1988) exists elsewhere. Children in societies that depend partially upon foraging do seem to procure and consume a disproportionate amount of wild fruit. Children are particularly heavy consumers of wild fruit in a variety of cultures (Fleuret, 1979; Johns, 1990; Laderman, 1991). However, there is little cross-cultural data on age differences in preference for vegetables, or for age differences in food habits generally. It is possible that the food patterns discussed in this paper are attenuated in environments where resources are less abundant or where the range of foods in the diet is different.

The evolutionary explanations proposed for these findings will also require additional sources of evidence. Nonetheless, it is useful to raise these arguments and evaluate their fit with existing data, because they suggest new lines of research that would not be anticipated from other theoretical perspectives. It is appropriate, therefore, to consider further test implications of these ideas.

By definition, a sensitive period for learning a given behavior implies that learning (or unlearning) is difficult at other periods of development. If there is a sensitive period for food learning, therefore, children who are unable to eat the full range of adult foods during their first year or two of life might be expected to have a narrower diet breadth throughout life.

Indirect evidence lends support to this prediction. In an American sample of children aged two to nearly seven, children who had been offered a greater diversity of food were reportedly more willing to sample new foods (Pelchat and Pliner, 1986). In my own sample, children who were first introduced to solids unusually late (7 months or older) were pickier eaters than other children, and this difference persisted throughout childhood (Cashdan, 1994). This would be consistent with a sensitive period for food learning if late introduction to solids were to shorten the putative sensitive period. It would be useful to know whether people whose early diet was clearly limited (perhaps because of medical complications) also have a narrower diet when they are older. Even if the results are supported, however, caution is in order when making recommendations, since late introduction to solids may itself be an adaptive response to the type or abundance of available resources.

A second avenue for research on this problem lies in cross-species comparisons. If sensitive-period food learning is an adaptation that reduces the costs associated with learning about different types of food, we might expect to find it more frequently among herbivores and omnivores than carnivores (other things equal), since plant foods are more likely to contain toxic secondary compounds. As noted earlier, there is evidence for sensitive-period food learning in rats, sheep, and gorillas, but current information is patchy and a comparison of similar species with different diets would be instructive.

The benefits of a sensitive period for food learning and of initial caution toward non-fruit plant parts should be especially great among tropical herbivores and omnivores, since lowland tropical plants are more likely to contain alkaloids than plants at higher latitudes and alpine elevations (Levin, 1976) and the alkaloids present there are more toxic (Levin and York, 1978).[5] Tannins are also more abundant in tropical than temperate forests (Coley and Aide, 1991). This latitudinal gradient in plant toxins also suggests that caution toward vegetables and novel foods should be most adaptive for children in these environments, other things equal, and least important for children in arctic regions, where plant foods are both scarce and less toxic.

Although it is tempting to make the additional prediction that children will be most cautious toward the most toxic plant parts, operationalizing this prediction is difficult. It is not easy to make simple generalizations about the pattern of distribution of toxins within plants (McKey, 1979) and, as noted above, even the absolute magnitude of plant toxins may not be an adequate predictor since toxicity and food value interact in determining the net benefit of a food. The hypothesis suggested here, however, would gain support from evidence of a negative correlation (controlling for food value) between vegetable preference in children and abundance of toxic secondary compounds.

Conclusions

Eating problems are a source of concern to many parents, and parenting guides devote considerable space to the topic. In this paper, I have presented data on children's food habits and aversions, and suggested that they may fruitfully be viewed as evolved adaptations. Specifically:

1. The increasing food pickiness of older toddlers, which begins to show itself from two years of age, may be a natural consequence of a sensitive-period learning strategy, and probably evolved as an adaptation to the high costs associated with eating toxic and unwholesome foods.
2. An initial dislike of vegetables, shown by many western children, may have evolved in order to minimize exposure to natural plant toxins.
3. Many of the behaviors that so irritate parents, such as picking one type of food out of a salad or casserole, or insisting on spaghetti without the sauce, probably help in the process of identification of the food item and the consequences of eating it. These behaviors, therefore, may be evolved preferences that help children identify and learn about food.

Parents are often advised – with good reason – to relax about their child's eating behavior and not worry so much. Yet this is often difficult for them to do. If it can be shown that these behaviors are sensible adaptations for learning about food, parents should be better able to accept their child's food habits with equanimity.

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Notes

1. Because I chose to use retrospective data, I was interested to know how recall affected the results. Would parents of older children remember age changes during their child's first five years, or would their responses differ systematically from those of parents of younger children? When data on age changes in receptiveness to foods offered by parents were computed separately for three age groups, the pattern remained for all groups but became attenuated with age. In other words, the salience of these early changes decreased as the time from the event increased, but the same basic pattern was reported by all parents. For this reason, data from all children are pooled in the discussion that follows.

2. A decrease in finickiness about items known to be food is not surprising, since research consistently shows that preference increases with familiarity. A decline in neophobia is harder to explain. Perhaps adults and older children are aware that researchers in the food lab would not offer genuinely dangerous items, whereas a young toddler may view the food lab as no safer than the woods. I expect that if adults and children were asked to gather and eat genuinely novel and unknown wild plants, the adults would be as neophobic as the children.

3. William Chasko (unpublished notes) recorded counts of all plants other than grasses found along three transects in Northern Botswana in 1976–7. I interviewed Kalahari residents about their uses of these plants in 1977. Most of the plant use data were obtained in group interviews of Basarwa (Bushmen) living along the Botletle River, although some information was also obtained from a Kalanga healer. The Botletle River Basarwa depend on both wild and cultivated foods (Cashdan, 1987), while the Kalanga are pastoralists/farmers. Some supplementary information was obtained from Steyn (1981), Lee (1979), and Vierich and Hitchcock (1978). Table 1 does not distinguish the information obtained from these different sources, hence does not necessarily describe use by a single ethnic group.

4. While the causal arrow underlying the relationship between familiarity and vegetable preference in children could logically go both ways, much is probably due to the effects of mere exposure on preference. Watercress, for example, was both the least favored and least familiar vegetable in Alford and Tibbets's study. It seems unlikely that parents were deliberately withholding watercress from their children because their children had expressed distaste for the vegetable. The effect of exposure on preference seems a more reasonable explanation for this relationship.

5. Although within tropical regions, at least in Africa, harmful alkaloids are apparently less abundant in the dense tropical forests (Hladik, 1990).

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