E. Do Chili-Experienced and Chili-Naive People Experience the Same Sensations?

Dislikers of chili often complain that the burn of chili pepper makes it difficult to experience other flavors, whereas likers often talk about chili pepper as enhancing flavor. If we accept these reports at face value, the explanation could occur at a sensory or cognitive level. Lawless, et al. (1985) report that the presence of capsaicin reduces magnitude estimations for solutions of basic tastants or odorants, but that this effect appears in roughly equal amounts for chili likers and dislikers. Cowart (1987), using a different procedure (see chapter by Cowart), finds no masking effect in either likers or dislikers. Neither study reports a difference in the masking power of the burn in likers vs. dislikers.

Independent of masking effects, one can ask whether there is a difference in sensitivity to capsaicin in likers and dislikers. Given the phenomenon of desensitization, which can occur topically (Jancsó, 1960, 1968; Jancsó-Gábor and Szolcsányi, 1969; Szolcsányi, 1977), a desensitization might well occur in frequent users. Before exploring this issue, it is important to realize that even if desensitization occurs in users, it could not account for the liking for chili pepper. At most, desensitization by itself would make an aversive sensation less aversive. This point is emphasized by research on chili preference and desensitization in rats (Rozin et al., 1979). Although almost a year on a very piquant diet did not cause a significant reduction in aversion to that diet (in comparison to the same diet without chili pepper), desensitization of rats to capsaicin by systematic injection caused them to be indifferent to the chili-flavored diet. This study indicates both that desensitization could only account for a reduction in aversion and that chronic oral exposure to piquant foods does not seem to have a long-term desensitizing effect. Nonetheless, data from humans would be most relevant and are indeed available. The evidence indicates at most a slight desensitization from chronic use.

1. Mexicans eating chili regularly show a burn detection threshold for chili pepper, measured by exposure to increasing levels in a palatable cracker base, that is only about 1 log(2) unit higher than the threshold for American subjects (Rozin and Schiller, 1980).
2. American chili likers show a 0.6 log(2) unit increase in detection threshold, using the same type of measure as above, in comparison to Americans who are neutral to chili or dislike it (Rozin and Schiller, 1980). Similar results are found with threshold tests using solutions made with pure capsaicin (Rozin et al., 1981).
3. There is a significant but small decrease in capsaicin sensitivity in American chili likers, measured by their salivation to a series of increasing concentrations of capsaicin. It requires about 1.5 log(2) units more of capsaicin to achieve comparable salivation increases in strong likers as opposed to neutral/dislikers.

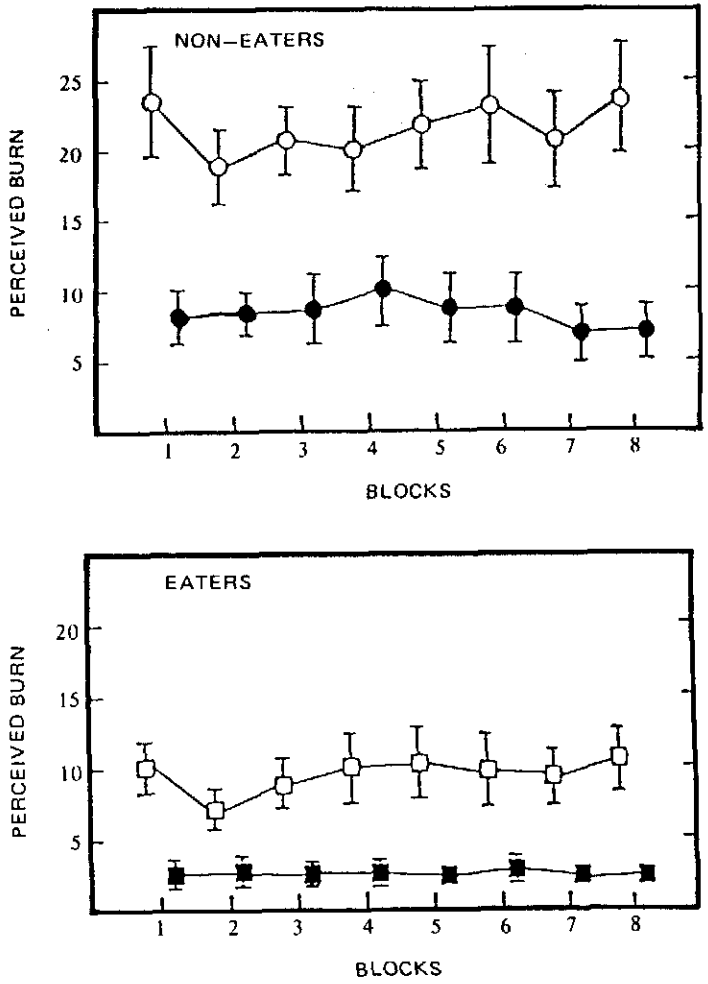

FIGURE 3 Magnitude estimation (mean ratings, plus or minus 1 standard error of the mean), relative to a sound standard, of the intensity of burn of capsaicin solutions, by chili eaters and chili noneaters. Open symbols show the ratings just after expectoration of a capsaicin rinse solution, and closed circles show the rating after four intervening judgments on qualities of other solutions. This cycle or block (rinse, burn rating, four test solutions, burn rating) was repeated eight times (Lawless et al., 1985).

4. The correlation between the detection threshold and the level that produces a peak preference is positive (as desensitization would predict) but rather weak (0.29-0.39 in different measurements). For the sake of comparison, the correlation between peak preference and tolerance (the highest level that will be voluntarily accepted) is in the range of 0.69-0.83 (Rozin and Schiller, 1980).

These findings suggest that there is a small desensitization effect which may modulate responses to chili pepper but cannot account for the liking for chili pepper. Note that chili likers report that they *like* the burn; it isn't that they fail to sense it.

Desensitization on a major scale may occur under extreme conditions. Two adult Mexicans who ate extremely large amounts of chili pepper, including frequent ingestion of whole, fresh pepper, showed no aversion to our strongest stimulus, 262,000 SU, nor did they show any physiological signs (e.g., sweating) in response to such oral doses (Rozin and Schiller, 1980). These two individuals continued to enjoy highly piquant foods.

Desensitization is measured in terms of threshold. Suprathreshold response to capsaicin-induced burn differs much more markedly between likers and nonlikers than does threshold. This could be an amplification of a small threshold difference. However, it is more likely that it is generated at a different level in the system. Both Lawless et al. (1985) and Cowart (1987) report markedly higher ratings of capsaicin burn intensity in chili dislikers (see Cowart, this volume). Subjects in the Lawless et al. (1985) study had their magnitude estimations anchored with loudness intensity of auditory stimuli, so that the comparisons between the two groups had a common metric (Fig. 3).

IV. THE ACQUISITION PROCESS

A. The Natural History of Chili Preference Development

Studies on the development of alcohol and tobacco preferences suggest that the acquisition of preferences for innately unpalatable substances can be divided into two phases. First, initial exposures occur in the absence of a liking for the substance; curiosity and social pressure, particularly the desire to appear adult, often motivate the novice (Albrecht, 1973). Some ingestion may be "forced" by lack of availability of alternatives or by incorporation of the substance into obligatory ritual practices (Damon, 1973). Social pressure seems to be the dominant force in the first stage. For those person who enter the second stage, the sensory properties become pleasant in themselves. It is this transition that is of fundamental importance in the study of the acquisition of values and central interest in understanding the liking for chili pepper (Table 4).

TABLE 4 Process of Exposure and Internalization

	STAGE ONE (exposure)		STAGE TWO (internalization)
CHILI PEPPER	Exposure to increasing amounts, under mild social pressure →		Preference becomes internalized by development of a liking for the taste
	↓ Consumption ceases	↓ Consumption continues, but only under social pressure	
COFFEE OR TOBACCO	Exposure, under strong social pressure from peers, and motivation by desire to "be adult" →		Internalization by habitual use Internalization by anticipation of positive effects Internalization by anticipation of avoidance of negative withdrawal effects (addiction) Internalization by development of a liking for the taste ("affect")
	↓ Consumption ceases	↓ Consumption continues, but only under pressure	

Source: From Rozin, 1982.

The development of preferences for chili pepper in various cultural contexts seems to follow this two-stage model, with a relatively early age of shift to the second stage, in comparison to alcohol, tobacco, or coffee (Table 4). Young children seem to be protected from exposure to chili (at least at moderate to high levels) (see Rozin and Schiller, 1980 for Mexico; Hauck et al., 1959 for Thailand; Bergsma, 1931 for east Africa). Depending on the culture, preferences based on liking for the flavor/burn seem to appear in the range of 4-11 years of age (e.g., Hacker and Miller, 1959: ages 10-11; Rozin and Schiller, 1980: ages 4-7).

American (college students; N = 57) subjects were asked: "How did you get to start eating chili?" (Rozin and Schiller, 1980). The most common re-

sponses among chili likers were that it was used at home (37%), that the parents put it on the food (29%), and that the first exposures were in restaurants or eating out (18%). In the response to the question: "How did you come to like chili?" the most common answer was that it was never disliked (43%). The next most common responses were development of a taste (23%), through exposure (23%), and enhancement of the flavor of food (11%). Although almost half of the subjects claimed never to have disliked chili pepper, interviews with parents in Mexico and the United States suggest that it is rare for children under 2 years of age to like chili pepper. Indeed, it is used on the mother's breast in a number of cultures to discourage nursing (Jelliffe, 1962). On the other hand, one parent reported a definite preference for piquant foods in a 1-1/2-year-old child, and the author has been present on two occasions when a young adult tried piquant food for the first time and liked it.

A group of 207 college students was asked on a questionnaire: "If you like chili pepper or other spices that produce a burn, indicate how many times you tried it before you liked it?" I do not pretend that people can respond to this question accurately, but their response is still likely to be informative. Most responses fell between 2 and 100 times, although 14.8% of subjects claimed to have liked chili pepper on the first tasting (Table 5).

Interviews with Mexican adults about their own early experiences with chili, interviews with Mexican mothers regarding the early exposure of children to chili, and observations of meal times in Mexican village homes all indicate uniformly that chili is introduced gradually into the young child's diet (Rozin and Schiller, 1980). Although infants may incidentally taste piquant adult foods (in which the chili pepper is cooked in with the food), no attempt is made to introduce hot foods to them. Gradually, from about 3 years on, small amounts of chili (salsa) are placed on tortillas and the accompaniments. No specific rewards are given to children for eating piquant foods, but they observe the avidity with which parents and older siblings consume it. All informants and observations lead to the conclusion that by 5 or 6 years of

TABLE 5 Number of Times to Liking of Chili or Other Irritant Spices

Number of times	N	%
1	29	14.8
2-5	50	25.5
6-25	25	12.8
26-100	92	46.9

Note: N = 196 American undergraduate students who like chili pepper.
Source: From Rozin, unpublished.

age, children seem to like piquant food, and voluntarily add salsa to their food.

These observations are confirmed by direct preference measurements on subjects in a Oaxaca village, in the age range of 2 years to adulthood (Rozin and Schiller, 1980). A common snack, purchased in a few small stores in the Mexican village under study, was flavored powder in a small cellophane package. One type of snack consisted of four different types of fruit flavorings with appropriate coloring, each mixed with sugar and a sour powder (presumably citric acid). This snack was called *sal de dulce*. Another type of snack, with a distinctive deep red color that differed from the color of the fruit snacks, consisted of salt and ground dried chili pepper (*sal de piquante*). This snack was purchased and consumed frequently by residents, primarily but not entirely children. All of the children in the village elementary school and a selection of adults and younger children (down to age 2) were given a preference test in which five (four different sal de dulce and the sal de picante) were displayed, and the subjects were asked to pick the one they wanted.

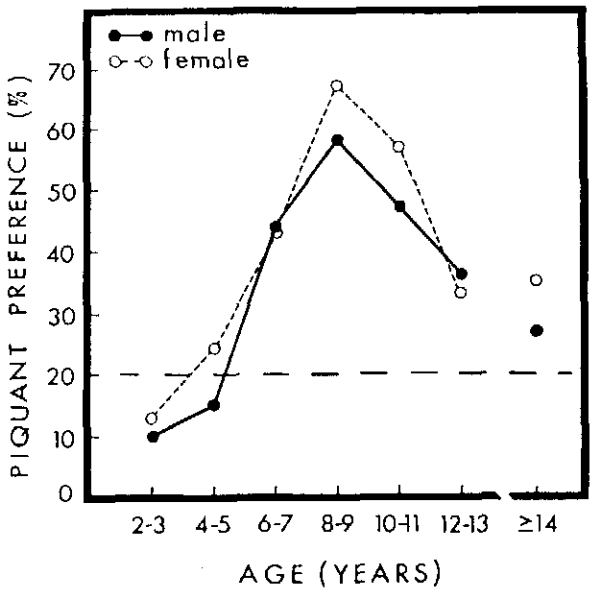

FIGURE 4 Preference for a salty-piquant snack (sal de picante) vs. four sweet-sour snacks (sal de dulce) by Mexican villagers, age 2 to adult. The dashed line indicates the predicted level of piquant selection if the subjects chose randomly. The points represent data from a minimum of eight to a maximum of 32 subjects. (From Rozin and Schiller, 1980.)

They were then allowed to open and eat the selected item. Age and sex were recorded for each subject. All subjects were familiar with these items and were aware of the relation between color and taste. Altogether, 265 subjects were run (52% female). The results are totally consistent with verbal reports and observations: a preference for the piquant snacks over the sweet-sour snacks emerges by age 6-7. The preference remains high, peaking at age 8-9 (Fig. 4). Note that the less preferred sweet-sour items are highly palatable; the preference measure indicates relative palatability. The remarkable finding is that in the early school years, a chili-salt snack is preferable to a sweet-sour fruit snack. There is no obvious explanation for the drop from the peak after 8-9 years of age; the peak might reflect an enhanced preference because of the importance at that age of demonstrating an adult preference. There were no sex differences in preferences.

B. Changes in Response that Occur During Preference Development

Chili likers differ from chili dislikers or chili-naive people in a number of ways with respect to their reaction to experiencing chili seasoning. I will summarize these differences, each of which seems to correspond to a more or less gradual developmental change. The occurrence of gradual developmental change is an inference from the observation of current differences in reactions to chili in different people, and the general observation that the changes tend to occur gradually. A number of authors who have discussed chili pepper refer to this gradual acquisition (Schweid, 1980; Heiser, 1985). Charles Heiser, a botanical expert on chili pepper, gradually came to like the burn of chili pepper, in the process of working with the peppers.

Rozin et al. (1982) evaluated preferences for chili pepper in 40 American subjects by offering them a series of crackers with increasing piquancy, from 0 to 8500 SU. Subjects tried each cracker and rated how much they liked the sensations produced every 10 sec for the first minute, and every 30 sec thereafter, using a scale that ran from −100 (the worst possible taste imaginable) through 0 (neutral) to +100 (the best possible taste imaginable). Subjects continued up the series of crackers unless they felt that the next cracker would be too unpleasant, in which case the series was terminated. Almost all of the subjects could be classified in one of three categories. Strong dislikers (N = 16) essentially disliked all chili-adulterated crackers. The blank cracker was at least as pleasant as any other cracker (Fig. 5A). The existence of a substantial group of strong dislikers indicates that there is not a very low level of irritation that is universally likable; rather the sensation is probably totally negative, at any level, to novices. Strong likers (N = 7) found all levels of chili enhancing, both while the food was still in the mouth (the first minute or so), and during the residual isolated burn, which may have lasted many

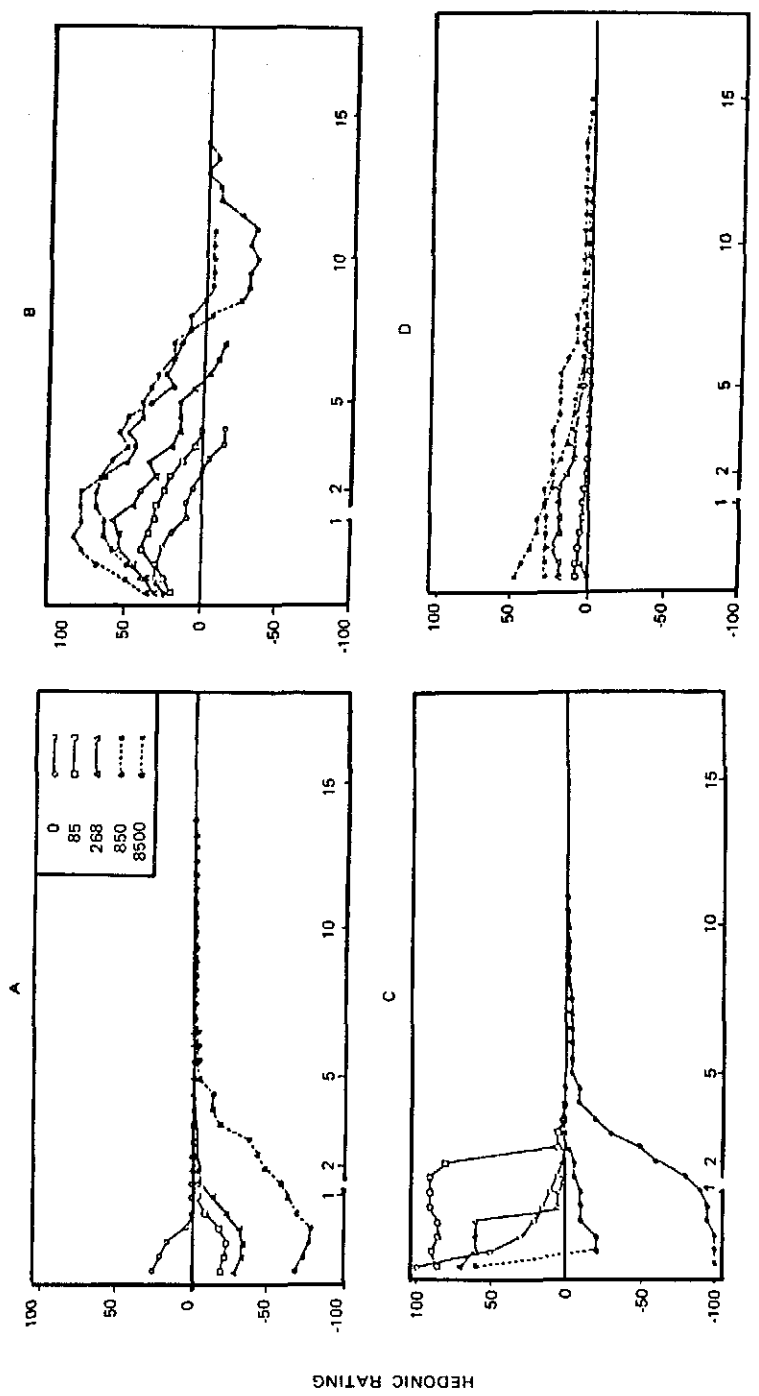

FIGURE 5 Temporal hedonic response to crackers with different levels of chili pepper by American adult subjects. Open circles, 0 Scoville units (SU); open squares, 85 SU; open triangles, 268 SU; closed circles, 850 SU; closed squares, 8500 SU. Each panel shows the response to each of the stimuli for one representative subject. Panel A represents a typical disliker. Panel B represents a person who likes the burn with the flavor, but not the isolated burn. Panel C represents a subject who likes low levels of burn but not high levels. Panel D represents a typical liker. (From Rozin et al., 1982.)

minutes (Fig. 5D). Moderate likers (N = 14) showed a shift from like to dislike as the piquancy of the crackers increased. In some cases, the flavor enhancement of the burn was evident at all levels, but there was a negative response to the stronger residual, isolated burns (Fig. 5B). In other cases, the full sensation for the weaker crackers was positive, while the whole sequence of sensations for the stronger crackers was negative (Fig. 5C). It seems highly likely that most of the strong likers went through a moderate-like stage. The results of this study and other research (e.g., Rozin and Schiller, 1980), suggest the following developmental changes.

1. Over weeks to years, the most preferred level of piquancy rises. In early stages, only slight burns are preferred. However, this process does not continue indefinitely. People stabilize at some level and subsequently continue a peak preference at that level. Both Mexican and American subjects were presented with a series of corn snacks with increasing levels of piquancy (from 0 to 262,000 SU, with each stimulus twice the level of its predecessor). Subjects were asked to indicate whether they preferred each snack to its predecessor. They were quite consistent in this task in that once they ceased to prefer a snack to its predecessor, they almost invariably rated subsequent snacks as less palatable than their predecessors. The preferred level was set at that snack which was preferred to both its predecessor and follower. The sequence was continued until the subject declined to try the next stronger snack. The last consumed snack was designated the tolerance level. A similar series of measurements was made using a different, tortilla vehicle. For Mexican subjects between the ages of 4 and 15 years, the correlation between age and preference was 0.20 (n.s.) for the corn snacks and 0.52 ($p < 0.025$) for the tortilla crackers. The correlations between age and tolerance for these same subjects were 0.41 ($p < 0.05$) and 0.28 (n.s.), respectively. In contrast to these results, suggesting an increasing preference for stronger stimuli with age, corresponding correlations for Mexican adults (ages 18-56) were -0.07 for age-preference and 0.01 for age-tolerance (Rozin and Schiller, 1980). These results support the view that a gradual increase in preference subsequently stabilizes. In the natural setting, where chili is a normal part of the diet and is introduced well before the fifth year of life, maturity seems to be the point at which preferences stabilize.

2. Preference initially appears as enhancement of the flavor of other foods. As shown clearly in the first minute of the curves in Fig. 5B-D, chili enhances the flavor of a food, the more so as the preference increases (this is, of course, a major part of the definition of preference increase). The major justification given by Mexicans for eating chili is that it adds flavor to foods (see above).

3. There is an extension of the food contexts in which the burn is perceived as pleasant. Liking for the burn seems to begin in the context of a

TABLE 6 Contexts for Chili Pepper for American College Students

Context	Percent who eat chili in that context
Pizza	54
Meat/fish	47
Hoagies (submarine sandwiches)	44
Vegetables	36
Snacks/crackers	14
Beverages	14
Sweets	4
Dairy	4
Fruits	4

Source: Rozin (unpublished).

specific set of foods and/or food/meal situations. With exposure, the range of contexts that are appropriate grows. This sequence is suggested by questionnaire results from American college student subjects, who were asked to indicate whether they ate chili pepper with a variety of foods, as listed in Table 6 (Rozin, unpublished). The basic pattern, similar to the pattern of use in Mexico, is for predominant use with main course items, and marginal use with sweets, beverages, dairy, and fruits. One may presume that those who use chili pepper with the infrequently used items also began with the more common items.

4. There is a reduction in the masking effect of chili on other flavors. As mentioned above, chili dislikers feel that it masks other food flavors, whereas likers do not hold to this view. Although this difference has not been demonstrated in laboratory sensory tests (Lawless et al., 1985), that is not to say that people are misreporting. Rather, it may be that the emergence of other flavors with experience with chili is more a cognitive than a sensory effect.

5. At later stages, there is a preference for the isolated burn of chili. Some chili likers like the burn that remains after all of the flavor of the food has disappeared (see particularly Fig. 5D). This seems to be a later development in the acquisition of preference, in the sense that it is less common than flavor enhancement. Another way to describe this characteristic is that the burn can be enjoyed outside of the immediate food context. However, we do not know that a pure isolated burn that did not arise from consuming a food would be pleasant. Such a burn might be unpleasant to almost everyone; our chili-liking subjects in studies in which they rinsed with capsaicin solutions (Rozin et al., 1981) generally found these solutions and the burn they produced unpleasant, even at low levels.

C. Theories of Preference Development

We do not know the mechanisms involved in the development of a liking for the burn of chili pepper. Unfortunately, we know very little about the mechanisms behind any acquired likes, for foods or other entities (see reviews by Beauchamp, 1981; Booth, 1982; Rozin, 1984; Birch, 1987; Rozin and Vollmecke, 1986). All of the mechanisms that have been suggested for other foods may be relevant for the case of chili pepper. Proposed mechanisms for foods in general can be divided into three categories: mere exposure, general mechanisms (often Pavlovian) that may account for acquisition of all food preferences, and special mechanisms that require that the food in question be initially aversive.

1. Mere exposure

There is no doubt that exposure is almost a necessary condition for liking; it is unlikely that one will develop a liking for a food that one has never tried. Zajonc (1968) holds that mere exposure induces liking, i.e., exposure acts not to allow other mechanisms to operate, but itself increases liking. This is a "null" position, in the sense that it is hard to eliminate the possibility of something else operating during the exposure period. Exposure to foods without any notable consequence can lead to increased liking (e.g., Pliner, 1982). Surely in the natural setting there is a great deal of exposure to chili pepper that should be more than sufficient to induce liking. Thus, insofar as one considers mere exposure a theory of liking, chili pepper is a reasonable candidate.

2. General (primarily associative) mechanisms

There is evidence for three types of associative mechanisms that may contribute to the acquisition of likes for foods. One is Pavlovian pairing of a food/flavor with positive postingestional consequences (Booth et al., 1982). Such effects are not always robust and may be limited to satiety effects, since there is no evidence that other types of postingestional consequences (relief of gastric pain, general feeling of well-being, drop in fever, etc.) have any effect in inducing liking (Pliner et al., 1985). These data imply that explanations of the liking for chili pepper in terms of changes in temperature that it produces are unlikely. Insofar as satiety is a potent US in a Pavlovian paradigm, the normal exposure to chili pepper could enhance liking through this route: chili pepper is typically eaten with satiating foods, in a meal context.

A second Pavlovian mechanism is pairing of a food/flavor (CS) with an already positive flavor (US). For example, Zellner et al. (1983) showed that pairing a flavor with a sweet taste enhances the liking for that flavor in comparison to a different flavor presented an equal number of times but not paired with sweetness. It is probable that some of the liking for coffee is induced by early exposure to sweetened coffee. Chili pepper liking could be fostered by such pairing, since the chili is eaten with all of the basic main course foods, although it is not paired much with particularly palatable sweet dessert tastes. Furthermore, the salivation produced by chili pepper is said to enhance the flavor of food and may be a component of the pleasant oral US.

The most well-documented and almost certainly the most potent force in creating likes is social (see Birch, 1987; Rozin, 1988 for reviews). The perception that a food is enjoyed or valued by respected others seems to be the critical social event. This can be construed as a Pavlovian linkage between positive social expressions of others (US) and the food (CS), or a more cognitive framework can be applied. In either event, the experimental evidence, coming largely from the laboratory of Leann Birch, documents the importance of such factors in children. There is abundant evidence for the operation of social factors in the acquisition of chili preference. In those cultures where chili is a part of the flavor principle, children observe the enjoyment of chili pepper in parents and older siblings in every meal. Furthermore, Birch and her colleagues (1982) showed that explicit rewards given for eating a food retard the development of a preference for that food. In the Mexican home situation, rewards for eating chili are *not* given (Rozin and Schiller, 1980). Rather, there is mild social encouragement. The acquisition of liking for chili pepper among adults, as in the United States, often occurs in the context of encouragement from friends who eagerly consume it. Finally, as indicated above, the only clear cases of acquired preferences for chili in animals involve social mediation. In summary, social factors are a very likely influence in the development of a liking for chili pepper.

3. Mechanisms that presume an initially aversive response

Two mechanisms for liking chili pepper have been suggested that depend on an initial negative response. They are opponent-endorphin responses and benign masochism (enjoyment of constrained risks).

a. Opponent-endorphin responses

Typically, a liking for chili arises after a number of unpleasant, painful oral experiences with chili pepper. Social forces encourage people to continue to sample unpleasantly piquant foods, which would otherwise be avoided after the first taste. Opponent process theory (Solomon and Corbit, 1974; Solomon, 1980) provides a model for just such a series of events. Within the framework of hedonic homeostasis, it holds that departures from hedonic (or other) equilibria (known as the A process) are reduced by the generation of processes opposite to the process that initiates the departure. The theory holds that this opponent, or B, process is initially weak, sluggish, and short in duration. With repeated stimulation of the A process (e.g., by successive exposures to

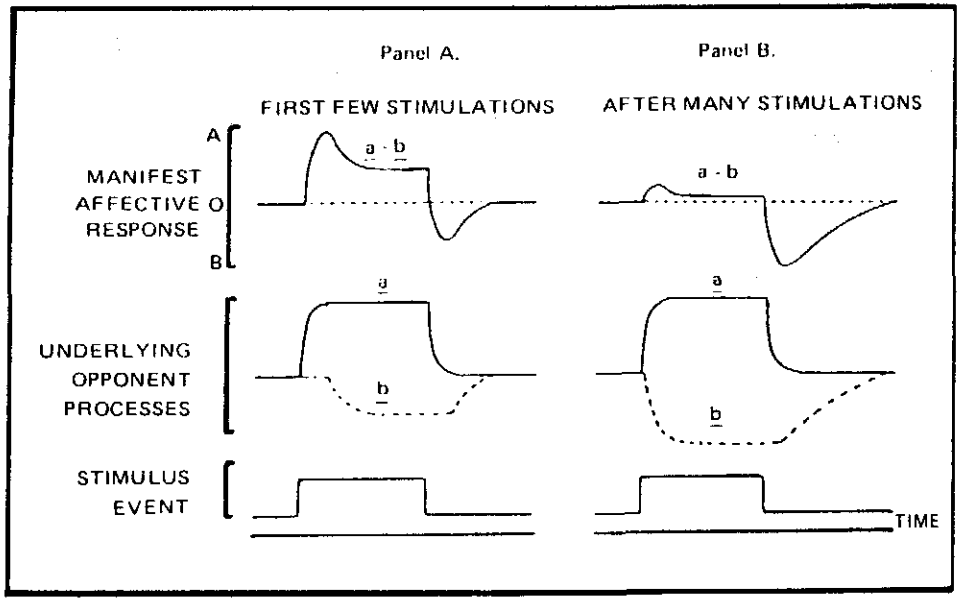

FIGURE 6 Schematic representation of opponent process theory. Panel A represents the operation of the system for the first few stimulations. Panel B represents the operation after repeated stimulations. The manifest response is the summation of the two underlying processes. (From Solomon and Corbit, 1974.)

a stimulus such as nicotine or pain), the B process becomes stronger, more rapid in onset, and longer in duration (see Fig. 6). Ultimately, the B process dominates and accounts for withdrawal effects. According to the theory, the potentiation of the B process depends on reinstitution of the A process before the previous B process has dissipated (Fig. 6).

A variant of this theory holds that the opponent process is not innately linked to the A process but is a conditioned response whose adaptive value is to cancel the perturbation produced by a stimulus (Siegel, 1977; Schull, 1979). The conditioned opponent view does not require that stimulation occur with short intervals; it simply holds that the conditions that promote Pavlovian conditioning will promote the development of conditioned opponents. Either theory would account for a negative to positive hedonic shift by presuming that the opponent process became stronger than the A process. If, after many exposures, there is a purely positive response, with no initial indication of negativity, the conditioning theory would account for this by holding that the opponent process anticipated the arrival of the stimulus. Both

of these theories have potential application to the acquisition of a liking for chili pepper; both types of processes may occur.

A likely physiological basis for chili liking within an opponent process frame is the secretion of brain endorphins. Substance P, known to be released in some neurons by topical stimulation by capsaicin, is a stimulant for the endorphin system. If the endorphins are presumed to be a part of an innate B process, this endorphin response could be accentuated by exposure according to the Solomon model. Alternatively, endorphin secretion could result from compensatory conditioning according to the Siegel model. In either case, the idea is that increasing levels of endorphin response to the same painful input could produce a positive feeling and convert the pain to pleasure. Indeed, one of the most successful areas for the application of both opponent process theories is heroin addiction, an opiate endorphin-related system. These theories fit well with Weil's (1976) description of the chili liker's experience as a rush, a form of "mouth surfing."

The gradual development of liking, the "high" that sometimes is described on eating chili, the conversion from pleasure to pain, and the substance P/endorphin link all suggest the reasonableness of these theories. However, there are some problems. First, a liking for chili pepper and other forms of pain seems to be almost uniquely human, yet the processes invoked are demonstrably common in animals. Second, chili dislikers do not typically show a positive hedonic effect as the negativity of a taste of chili wears off (Rozin et al., 1982); opponent effects are not often seen in the hedonic response to pepper stimulation. Third, Solomon's theory holds that the enhanced B process will return to normal levels with disuse. There is no evidence that chili preference abates after a period of weeks to years of nonstimulation. The conditioning view does not predict this dissipation. However, it does predict that when a person comes to like a particular food that is served with chili pepper, she should experience especially high pleasure if the same food is served without hot pepper, since the opponent pleasure response would be induced without induction of the A process. It also predicts that if this same food is presented many times without chili pepper, the next time it appears with chili pepper it will not be particularly pleasant (extinction of the Pavlovian positive hedonic CS). These two predictions of the Siegel compensatory conditioning approach have not been tested, but it seems unlikely that the predicted results would appear.

The direct test of opponent endorphin models would be either to measure increases in endorphins in chili likers in response to eating chili, or to show that blockage of the endorphin system blocks the liking for chili pepper. I have been involved in two attempts to do the latter. In both cases (two unpublished studies, one in collaboration with Schull, and the other with O. and C. Pomerleau), chili likers consumed and rated crackers of varying hotness

under conditions of intravenous administration of either vehicle or vehicle plus naloxone, double blind. The results of both studies were less than definitive. There was a marginal statistically significant tendency for subjects under naloxone to rate piquancy as slightly less pleasant. These differences are in the predicted direction but small in comparison to the robustness of the chili-liking phenomenon. Given that there are multiple endorphin systems, blocked to different degrees by different blockers, and that dose of blockers seems to be a critical variable in this literature, it would seem that systematic studies with varying doses and different blockers would be necessary to test the endorphin hypothesis. This has yet to be done.

b. Benign masochism (enjoyment of constrained risks).

Liking chili pepper is like liking to ride a roller coaster. In both cases, the body senses danger and behavior normally follows which would terminate the stimulus situation. In both cases initial discomfort becomes pleasure after a number of exposures. Yet chili pepper still burns in the mouth, and the sympathetic system is still highly aroused as the roller coaster plunges toward earth. It is as if the mind realizes that these activities are actually safe, but the body does not. This body/mind disparity may be a source of feelings of mastery and pleasure, a case of body over mind. We have suggested that this form of "benign masochism" or enjoyment of "constrained risk" is a particularly human quality (Rozin and Schiller, 1980; Schweid, 1980). It appears abundantly in humans, in dangerous sports activities, amusement park rides, preferences for innately unpalatable substances, watching frightening or sad movies, or taking painfully hot baths. While such activities are a common part of human life, they are very rare in animals. Thus, one virtue of a benign masochism interpretation of a liking for chili pepper is that it accounts for the virtual absence of this phenomenon in animals.

There is a modest amount of evidence that suggests a role for benign masochism in the liking for chili pepper. It is not uncommon for people to like the body's defensive responses, nose and eye tearing, made in response to consuming hot peppers. Eleven of 15 Mexican adults who reported such effects from eating chili pepper claimed to like them, as did 11 of 32 Americans (Rozin and Schiller, 1980). The preferred level of chili pepper is often very close to the highest level that would be tolerated, suggesting that liking is related to pushing the limits of pain tolerance (Rozin and Schiller, 1980). Nine of 36 Mexican adults rated the most preferred level of piquancy in a series of crackers of increasing piquancy at the same level as the tolerance level, and 13 more of these subjects rated the preferred level just one log(2) level below tolerance (Rozin and Schiller, 1980). Furthermore, people who prefer higher levels of piquancy tend to show a smaller difference between the preference and tolerance levels; the correlations between preferred level and tolerance − preferred level is about -0.40 in a few studies of Mexican and Americans (Rozin and Schiller, 1980).

TABLE 7 Correlations (Pearson) Between Liking for Chili Pepper and Liking for Risk-Related Activities

Activity	Pearson r with chili pepper liking
Amusement park rides	0.22
Gambling	0.19
Nose running or eye tearing from eating chili pepper	0.17
Dangerous sports	0.09
Roller coaster rides	0.03
Pain from running/jogging	0.03

Note: N = 150-250 American undergraduates. All ratings on a 9-point hedonic scale.
Source: From Rozin; unpublished.

Zuckerman (1979) developed a sensation-seeking scale which measures a personality variable that relates to what we have called benign masochism. One subscale of sensation seeking is called thrill seeking, and it seems to be particularly close to benign masochism. The existence of Zuckerman's personality scales indicates that there is some positive correlation between indices of thrill-seeking behaviors in different domains. My data support this weakly. Chili preference in Americans correlates 0.11 with a combination of three measures of benign masochism in other domains: liking sad movies, hot baths, and dangerous sports (Rozin and Schiller, 1980). In a different unpublished study of about 200 American undergraduate subjects, there were generally positive correlations between liking chili pepper and liking other risk-related activities (Table 7). The overall pattern is for a positive but very modest relation. One problem for the benign masochism view is that, although in traditional Mexican populations males are much more oriented to thrill seeking and "macho" behavior, there is not a significant sex difference in the liking for chili pepper (Rozin and Schiller, 1980).

More generally, there is a literature suggesting a weak positive relation between sensation seeking or measures like it and liking for strong or spicy foods (Child et al., 1969; Kish and Donnenwerth, 1972; Brown et al., 1974; Zuckerman, 1979; Logue and Smith, 1986). Logue and Smith (1986) included specific questions on liking for chili pepper and Mexican foods in their study on American subjects. They found a significant 0.16 correlation of liking for chili pepper with the sensation-seeking scale, although the liking for Mexican foods did not show a significant correlation. Surprisingly, on the thrill seeking subscale, neither the chili pepper nor Mexican food-liking scores showed a significant correlation. [See chapter 11 in this volume, for a different link between personality (private body consciousness) and chili pepper ingestion.]

4. Summary

There are multiple models for coming to like chili pepper. There are convincing arguments against each of them, which indicates either that all are incorrect, or that there is more than one route to liking. But since there is evidence *for* most of the models as well as against them, it is most likely that at least some of the proposed models *do* have a role in fostering liking, whether or not there are new models to come. Although the end point, liking the flavor and burn, is simple in the case of chili pepper, the routes to this state are surely multiple.

V. CONCLUSIONS

Some may find this chapter irritating, in keeping with the sensation produced by its topic. Many basic issues have been raised, but few resolved. The widespread acceptance of chili pepper poses problems in many areas. It is a particular challenge for culinary historians, since chili pepper, on the face of it, would appear unlikely to be adopted. The strong liking for chili in light of its initial unpalatability is a challenge for the psychology of affect and for the study of the acquisition of culture. The multiple sensations produced by capsaicin challenge the notion of a single type of receptor for chemical irritation.

There are very few papers on the sensations produced by chili pepper, its cultural history or cultural context, or the acquisition of liking or the psychology of chili use. Because it is one of the most widely consumed substances in the world, the absence of literature is surprising. The study of chili pepper for its own sake, as an important part of human life, is more than justified. But chili pepper also offers us a tool to study some basic processes. Just as capsaicin has become a tool in the study of thermoregulation and neurotransmitters, the use of chili pepper offers relatively easy windows to the study of basic behavioral processes. One of these is the process of acquisition of liking in general. The reversal of liking that occurs with chili pepper occurs on a massive scale and represents one of the most dramatic changes in affective response that one can find. It should be possible to produce this under controlled conditions, as we (Rozin and Kennel, 1983) did with chimpanzees. This would allow the analysis and evaluation of different models for the acquisition of liking. It is a particularly good model system for studying the acquisition of liking for IUSs, including alcohol, tobacco, and coffee. Chili pepper has a special advantage; unlike many other widely used IUSs, chili is currently consumed for one reason: it tastes good. In this respect, it is a simplified system.

I hope that this chapter can stimulate more research on this remarkable food. Meanwhile, some will continue to like it hot. The questions are, why only some? and why anyone?

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