Appetite: Journal for Intake Research, 1982, 3, 341–351

The Special Role of Nausea in the Acquisition of Food Dislikes by Humans

MARCIA LEVIN PELCHAT and PAUL ROZIN
University of Pennsylvania

When nausea follows ingestion of a food people tend to develop a dislike for the taste of the food. Other negative events, such as diarrhea, respiratory distress or rashes often motivate avoidance of associated foods, but are much less likely to cause the foods to become distasteful. This is one of the first cases where a well defined event has been shown to produce a stable change in affective response to an associated object.

The distinction between liking the taste of a food and ingesting it is obvious on an everyday level. For example, the dieter's consumption of cottage cheese rather than ice cream contrasts with his/her greater liking for ice cream. In a characterization of basic psychological categories of food rejection, Rozin and Fallon (1980, 1981) made such a distinction, between rejections based primarily on distaste (negative sensory properties) and rejections based on danger (anticipated negative consequences of ingestion). Yet, with a few exceptions (Young, 1948; Rozin, 1979; Peryam, Polemis, Kamen, Eindhoven, & Pilgrim, 1960; Meiselman, VanHorne, Hasenzahl, & Wehrly, 1972), this distinction is rarely acknowledged. Often, intake alone is examined and therefore many different types of rejections are treated as equivalent. Thus, we know very little about what types of interactions with foods cause them to become viewed as distasteful as opposed to dangerous. This problem is important in itself, because it is basic to our understanding of motives for food acceptance and rejection, but also because it is a special case of the more general problem: Under what circumstances will an object change in affective or intrinsic value? We know very little about this basic issue for any domain of objects [but see Lepper (1980) for a description and analysis of the circumstances under which an object or activity will lose intrinsic value].

The problem can be attacked by the study of animals or humans: Each has particular advantages and disadvantges. The animal literature is rich in examples of adaptive food choice and in analysis of the mechanisms underlying these choices (Richter, 1942; Rozin, 1976). But the affect–intake distinction is hard to establish in animals. Most investigators find stronger and more rapidly acquired taste avoidances in rats when tastes are followed by "internal malaise" as opposed to peripheral pain (Garcia, & Koelling, 1966; Rozin, & Kalat, 1971; Garcia, Hankins, & Rusiniak, 1974; but see Krane & Wagner, 1975; Braveman, 1977 for qualifications). Attempts to define

This research was done in partial fulfillment of the requirements for the degree of doctor of philosophy for M. L. P. and was supported by NIH Grant HD 12674. We thank Stephen Brake, Alan Epstein, Harvey Grill, Dorothea Jameson Hurvich and Jonathan Schull for helpful comments on the manuscript and dissertation.
Reprint requests should be addressed to Marcia L. Pelchat, Dept. of Psychiatry, Montefiore Medical Center, 111 E 210 St Bronx, N.Y. 10467.

0195-6663/82/040341+11 $03·00/0

those internal events that are most potent for producing taste aversions have suggested a special role for stimuli coming from the upper gastro–intestinal system, especially nausea (Garcia *et al.*, 1974; Coil, Hankins, Jenden & Garcia, 1978; Coil & Norgren, 1981; Bernstein, Vitiello, & Sigmundi, 1980; but see Nachman & Hartley, 1975; and Gamzu, 1977 for indications that this may be an oversimplification). However, the central issue in the present study, the quality of the learned avoidance, was not directly addressed in the studies just described. The preference measure used in these studies indicates avoidance, but does not distinguish between distaste and danger.

A few investigators have suggested that the critical difference between "malaise" (nausea?) and peripheral pain may not be only in strength of avoidance, but also in the quality of the avoidance. Specifically, only malaise may cause a change in palatability (Rozin & Kalat, 1971; Garcia *et al.*, 1974; Gleitman, 1974). Evidence for a distaste–danger distinction in animals comes from the observation that malaise based avoidances generalize to the paired food outside of the testing situation (Garcia, Kovner, & Green, 1971), whereas shock based avoidances do not. These observations suggest that malaise paired tastes take on intrinsically negative properties (where the negativity is taken as a property of the object) while shock paired tastes are negative only within the training context (and not treated as negative in themselves). While these observations do not directly address the danger–distaste issue, they support such a distinction because palatability can be seen as an intrinsic property of foods. More direct evidence for palatability changes comes from the observations that foods associated with malaise elicit behaviors similar to those shown by the rat to innately bad tasting foods, such as quinine (Rozin, 1967; Grill, 1975). We have confirmed these findings, using the rat's orofacial response (Grill and Norgren, 1978) as a measure of affect, and have shown that the "affective shift" does not occur for avoidances based on pairings with peripheral shock (Pelchat, Grill, Rozin and Jacobs, Note 1).

The study of this problem is easier in humans, in that we have much better measures of affect: verbal report and well documented facial expressions. However, the consequences of ingestion are not under the experimenter's control for obvious ethical reasons.

There are, however, a few studies on naturally occurring and experimentally produced taste aversion learning in humans (Garb & Stunkard, 1974; Logue, Ophir, & Strauss, 1981; Lamon, Wilson, & Leaf, 1977; Bernstein, 1978; Bernstein & Webster, 1980; Rozin & Fallon, 1980) and, as in the animal literature, there is some evidence for greater potency of internal discomfort in establishing food avoidances. Shock is less effective than nausea in reducing intake of paired food (Lamon *et al.*, 1977) and, of drugs used in the treatment of neoplastic diseases, those with no gastrointestinal (GI) side effects are less effective in producing conditioned rejections than are those with GI toxic effects (Bernstein, 1978; Bernstein & Webster, 1980). The critical issue is not whether "internal discomfort" is more effective at producing avoidances, but whether these events produce a different type of avoidance, in which the associated object takes on affectively negative properties. The only evidence on this issue is questionnaire data which suggest that acquired distastes are more strongly associated with GI distress than are avoidances based on anticipated negative consequences (Rozin & Fallon, 1980).

We now report the first systematic test of the hypotheses that negative gastrointestinal symptoms have particular potency in causing negative affective shifts toward foods associated with them, and that the most potent gastrointestinal effect is nausea. In the present experiment, we take advantage of "experiments of nature" by

administering a questionnaire to subjects who have experienced illness or discomfort following ingestion of a particular food.

METHOD

Students and employees ($N = 198$, mean age: 21·7 years) at the University of Pennsylvania filled out a three-section questionnaire. Subjects were instructed to answer the questions in each section with respect to one specific food. The first section was for lactose malabsorbers, and the food considered was whole milk. We chose lactose malabsorbers as a target group because we were particularly interested in the effects of varieties of GI distress other than nausea or vomiting on intake and liking. In this group, diarrhea, cramps and gas are the primary symptoms when large quantities of unfermented dairy products are ingested (Johnson, Kretchmer, & Simoons, 1974). In the second section, subjects were asked to answer questions about one food that they were allergic to, and in the third, one food which had been accompanied by discomfort or illness (not caused by allergy or lactose malabsorbption). Overall, the 198 subjects who completed one or more sections, yielded a total of 245 instances of negative experience with food. The three sections of the questionnaire contained the same basic set of questions. The sections differed only in that the lactose malabsorption and allergy sections contained questions designed to screen out subjects who did not have these disorders. Of the questions that appeared in all three sections, those most related to the distaste–danger distinction were: (i) "How much did you like the taste of this food before the first time that it was accompanied by discomfort or illness?" (pre-like; in 37 of 245 cases, subjects did not report a pre-like). (ii) "How much do you like the taste of this food now?" (post-like). Questions (i) and (ii) were answered on a standard 9 point hedonic scale; 1 = dislike extremely; 2 = dislike very much; 3 = dislike moderately; 4 = dislike slightly; 5 = neither like nor dislike; 6 = like slightly; 7 = like moderately; 8 = like very much; 9 = like extremely. (iii) "What were the symptoms associated with eating this food? Circle all symptoms in the list below which apply. Indicate with a * which of these was the most disturbing". Symptoms were presented as a check-list. The order in which symptoms are given here is a conceptual one (based on similarity in symptoms) and is different from the mixed order in which they were presented to subjects: 1. nausea; 2. vomiting; 3. cramps or gas; 4. diarrhea; 5. stomach or abdominal pain; 6. heartburn or acid stomach; 7. bloating or stomach distension; 8. mouth sores or ulcers; 9. headache; 10. nasal or sinus congestion and/or runny nose and/or sneezing; 11. respiratory distress i.e., lung or bronchial congestion; asthma, labored breathing or coughing; 12. rapid pulse or palpitations; 13. sore or swollen throat; 14. water retention or swelling; 15. enuresis (involuntary urination); 16. shock or unconsciousness; 17. seizures or mental confusion; 18. fever or sweating; 19. cuts, scrapes, bruises or broken bones; 20. rash, hives or other skin reactions; 21. other—specify-----.

In addition, at the beginning of each section (after specifying the illness paired food), subjects were given the following free report question: "Briefly describe the circumstances under which you first became ill or uncomfortable after eating this food and describe the symptoms that you experienced." This information was used primarily to fill in missing answers to other questions, but was also used to check the reliability of answers. When conflicts occurred (in a few cases), subjects were contacted by telephone for clarification.

For ease of analysis, symptoms were grouped in the following way (the primary symptom was defined as the choice marked with a * on the symptom list). (i) Nausea–vomiting primary (Naus Prim): includes subjects listing nausea or vomiting as their primary symptom (1 or 2 on symptom list); (ii) Nausea–vomiting secondary (Naus Sec): subjects not listing nausea or vomiting as their primary symptom who did list one or both of these as secondary symptoms. All categories were mutually exclusive. Thus, subjects included in this category were not considered in any of the following categories regardless of primary symptom; (iii) Other GI: subjects listing cramps or gas, diarrhea, stomach or abdominal pain, heartburn or acid stomach, bloating or stomach distension or mouth sores or ulcers as their primary symptom (3–8 on symptom list); (iv) Other: subjects listing a non-gastrointestinal, non-cutaneous type of malaise as their primary symptom. Included in this category were headache, nasal or sinus disorders, respiratory distress, tachycardia, sore or swollen throat, water retention, enuresis, shock or unconsciousness, seizures and fever (9–18 on symptom list); (v) Skin: subjects listing rash, hives or other skin reactions as their primary symptom (20 on symptom list). We also asked subjects to estimate frequency of use of the relevant food before the negative event and at present (using a seven category frequency scale ranging from "never" to "more than once per day") and a number of other questions which will be described as they become relevant in the presentation of results.

Results

There were highly significant differences between symptom groups in liking measures (ANOVA, $F=7{\cdot}62$, $df=4{,}240$, $p<0{\cdot}001$ for post-like; $F=5{\cdot}02$, $df=4{,}213$, $p<0{\cdot}001$ for change in liking (post-like minus pre-like); Table 1). The combined groups with gastrointestinal symptoms (Naus Prim, Naus Sec and Other GI) had significantly lower mean post-like ratings than did the non GI symptom groups, and the Naus Prim group had significantly lower ratings than all other groups (Scheffe tests). Only the Naus Prim group had mean post-like ratings below hedonic neutrality (4·82); that is, only this group actually came to a net dislike of the taste of the food paired with discomfort or illness. There was no mean change in the Skin group's hedonic ratings and very little change in the ratings of the "Other" group. These results cannot be attributed to differences in prior attitudes to the specified foods, since the five groups did not differ significantly in their hedonic ratings of the food prior to association with illness (pre-like: $F=0{\cdot}99$, $df=4{,}213$, NS). In marked contrast to the post-like and change in liking effects, there was not a significant relation between symptoms (five groups) and change in frequency of ingestion of the relevant food (post-frequency minus pre-frequency; Kruskal–Wallis ANOVA, $H=1{\cdot}51$, $df=4$); subjects in all groups reduced their intake or use of the food paired with discomfort to about the same extent.

Although there were significant differences in liking across groups, the magnitude of the overall hedonic changes was small. We suspected that this was caused by extinction, since we had asked subjects for liking for the specified food *now*, rather than immediately after conditioning. Further, we suspected a systematic bias with respect to extinction that would reduce intergroup differences. Allergy sufferers and lactose malabsorbers should undergo little or no extinction, whether or not they try the food in question since in all probability, they will become ill if they eat the food again. These subjects formed the bulk of the Other GI, Other and Skin groups. On the other hand, the Naus Prim group was likely to have undergone a great deal of extinction if they did

try the food again, since food–nausea pairings were often the result of one time occurrences such as food spoilage or unrelated concurrent illness (e.g., the flu).

We repeated the hedonic analysis with the subset of our sample who eat the specified food now at a frequency of no more than once per year (Figure 1). As expected, all groups showed lower mean post-like ratings and larger changes in liking than in the full sample analysis. For example, the Naus Prim group showed a mean drop in hedonic rating of 1·65 points on the hedonic scale for the full sample, and a drop of 3·14 for the frequency restricted sample. Most critically, the differences between the groups were increased, supporting the hypothesis that there was an extinction bias in the sample, and strengthening the association between nausea and change in liking (for post-like, $F=10{\cdot}37$, $df=4,109$, $p<0{\cdot}001$; for change in liking, $F=6{\cdot}48$, $df=4,88$, $p<0{\cdot}001$; Figure 1, Table 1). The Naus Prim group was significantly different from all others for post-like and change in liking (Scheffe tests). And, by a much wider margin than before, only the Naus Prim group showed a net dislike in post-like ratings (3·28).

In order to make finer distinctions among GI symptoms, we performed an analysis limited to subjects with GI disorders (without the frequency restriction). Subjects were divided into four groups based on locus and type of primary symptom (unlike the prior analyses, we did not separate out subjects with nausea or vomiting as secondary symptoms; a subject reporting cramps as the primary symptom and nausea as a secondary symptom would be classifed in the cramps (Lower GI) group): (i) Nausea–vomiting; (ii) Upper GI (heart burn, bloating or stomach distension, stomach or abdominal pain); (iii) Lower GI (cramps or gas, diarrhea); (iv) Oral (mouth sores). Again, symptom groups differed significantly in post-like ($F=3{\cdot}97$, $df=3,172$, $p<0{\cdot}01$) and change in liking ($F=3{\cdot}53$, $df=3,156$, $p<0{\cdot}05$), with the Nausea–vomiting group

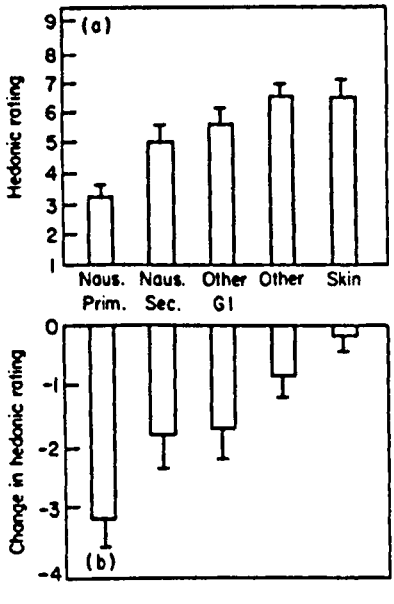

FIGURE 1. Current hedonic rating and change in hedonic rating for foods accompanied by one of five different types of negative symptoms. (a) Post-like; (b) post-like minus pre-like. The five symptom groups are: nausea or vomiting as a primary symptom, nausea or vomiting as a secondary symptom, other gastrointestinal disturbances, other disturbances (principally respiratory difficulties or headache) and skin disturbances. Observations are restricted to cases in which current frequency of use of the food in question is not more than once per year.

TABLE 1
Liking and change in liking as a function of symptoms

Data base	Symptom group	Post-like			Post-like minus Pre-like		
		N	Mean	Standard error	*N*	Mean	Standard error
Full sample							
	Nausea-vomit primary	74	4·82	0·32	66	−1·65	0·32
	Nausea-vomit secondary	33	5·67	0·42	26	−0·96	0·37
	Other GI	83	6·24	0·23	77	−0·51	0·16
	Other	31	7·00	0·29	29	−0·24	0·32
	Skin	24	6·96	0·44	20	0·00	0·28
Frequency restricted sample							
	Nausea-vomit primary	43	3·28	0·34	35	−3·14	0·43
	Nausea-vomit secondary	19	5·05	0·52	14	−1·78	0·54
	Other GI	18	5·61	0·56	15	−1·67	0·51
	Other	19	6·47	0·40	17	−0·82	0·37
	Skin	15	6·40	0·62	12	−0·17	0·27
GI Symptoms[a]							
	Nausea-vomit	74	4·82	0·32	66	−1·65	0·32
	Upper GI	31	5·94	0·40	27	−0·81	0·36
	Lower GI	61	6·18	0·28	58	−0·46	0·19
	Oral	10	6·00	0·54	9	−0·78	0·40

[a] Not frequency restricted. Assigned by primary symptom independent of absence or presence of nausea or vomiting as secondary symptoms.

showing the most negative post-like ratings and largest changes in liking (Table 1). The Lower GI symptoms had the smallest effect on both measures (Table 1).

Thus, in all three analyses shifts in liking differed across groups in a systematic way. GI discomfort was more effective than other types of discomfort and nausea was clearly the most potent GI symptom. Only subjects with nausea or vomiting as their primary symptom actually came (on average) to a net dislike (mean of less than 5 on the 9 point hedonic scale) for the taste of the paired food (Figure 1, Table 1).

Can we claim that symptom quality was responsible for the liking differences across groups? Could these differences in liking have been caused by other factors correlated with symptoms? We asked each subject about the harmfulness, delay of onset and unpleasantness of the primary symptom. Harmfulness was measured on a 4 category scale, varying from "life threatening" to "almost insignificant". Delay of onset of the primary symptom was measured on an 8 point category scale, varying from "in a minute or less" to "more than 24 hours". Unpleasantness was measured on a 9 point scale similar to the hedonic scale, and varying from "1 = extremely unpleasant" to "9 = extremely pleasant".

The relation between perceived harmfulness and symptom was not significant (Kruskal–Wallis ANOVA, $H = 8{\cdot}99$, $df = 4$, for the full sample). Delay of onset was significantly related to symptom group ($H = 14{\cdot}48$, $df = 4$, $p < 0{\cdot}01$ for the full sample),

but the correlation between delay and post-like was not significant (rho = 0·087). In fact, the group with the shortest delay (Other) showed little change in liking. The primary symptoms also differed significantly in unpleasantness ($F = 6·88$, $df = 4,240$, $p < 0·001$ for the full sample). The primary symptoms of subjects in the Naus Sec group were most unpleasant ($\bar{x} = 1·91$) followed by Naus Prim ($\bar{x} = 2·08$), Skin ($\bar{x} = 2·67$), Other GI ($\bar{x} = 2·73$) and Other ($\bar{x} = 2·74$). The correlations between unpleasantness of symptom with post-like (rho = 0·108, NS) and change in liking (rho = 0·193, $p < 0·01$) were weak but positive for the full sample. These same correlations within the Naus Prim group were somewhat lower (for post-like, rho = 0·018; for change in liking, rho = 0·148). Similar low correlations are reported by Logue *et al.* (1981) between ratings of nausea intensity and strength of acquired aversions.

In order to separate the effects of nausea and vomiting from the unpleasantness of symptoms, we analyzed selected subsets of the symptom groups with the same unpleasantness. Naus Prim remained the symptom category with the lowest mean post-like and largest mean change in liking. Three separate analyses were performed, using the frequency restricted sample, on subjects reporting that their primary symptom was "1" (extremely unpleasant), "2" (very unpleasant), or "3" (moderately unpleasant). These three unpleasantness categories accounted for 94% of the subjects meeting the frequency restriction criterion. Because of reduced numbers, we combined Naus Prim and Naus Sec into one "nausea" group, and compared it to Other GI, Other and Skin, combined into a second, "residual" group. The nausea group showed a lower post-like score at all three levels of unpleasantness ($p < 0·025$ or better, one-tailed t-tests). The nausea group showed a larger change in liking than the residual group. The difference in change in liking reached significance for unpleasantness levels of "1" and "2" ($p < 0·01$, one-tailed t-tests). Thus, perceived harmfulness, delay and unpleasantness of symptoms do not account for differences in liking measures across symptom groups. This supports the hypothesis that symptom type is the critical variable.

Finally, we asked each subject to rate his certainty that the negative symptoms were caused by the food in question. The scale used was: 1 = sure that it causes them; 2 = believe that it causes them; 3 = have no idea whether it does or doesn't cause them; 4 = believe that it doesn't cause them; 5 = sure that it doesn't cause them. Almost all subjects (201 out of 218) with change in liking scores were either sure (1) or believed (2) that the food caused their symptoms. These 201 subjects showed a smaller change in liking ($\bar{x} = -0·69$) than the 17 who were neutral (3) or doubted (4, 5) a causal link ($\bar{x} = -2·47$; $t = 3·57$, $p < 0·001$). Naus Prim subjects showed the highest mean score (1·74) on uncertainty (they were the least certain of the causal link between food and symptom) while Other showed the greatest certainty ($\bar{x} = 1·29$), but these differences are quite small.

Discussion

The identification of nausea as the most potent correlate of acquired distastes is an explicit demonstration of what has been implicit in a number of previous studies on rats and humans, and it parallels our demonstration with Grill and Jacobs of shifts in rat's orofacial responses to foods associated with nausea (Lithium Chloride poisoning) but not with shock (Pelchat, Grill, Rozin, & Jacobs, Note 1).

Our result reflects on the issue of special adaptations of learning (Garcia & Ervin, 1968; Bolles, 1970; Seligman, 1970; Rozin & Kalat, 1971; Shettleworth, 1972; Hinde,

1973; Revusky, 1977; Logue, 1979; Johnston, 1981). Discussion in this area has centred on the issue of qualitative vs. quantitative differences in the "laws" of learning in the "taste–visceral" system vs. other systems. While the question of the nature of the association *per se* is not addressed in this study, the major result suggests that an important difference among associations may be in their "read-out" (see Rescorla, 1980). That is, it is fair to say that a person with respiratory distress resulting from a shrimp allergy and a person with food poisoning following shrimp ingestion both associate shrimp with negative consequences. However, only for the food poisoned person is there an acquired distaste. The critical difference under discussion has to do with changes in response to external objects. Our claim is that nausea relates to the acquisition of bad tastes. This implicates nausea as both a potent agent for affective change and a means of changing the intrinsic value of objects. Shrimp tend to become intrinsically bad after food poisoning, while they tend to be seen as a cause or correlate of illness in the allergy situation. We believe that, for the poisoned person, the causal relation between shrimp ingestion and illness has no importance: whether the person thinks shrimp actually caused the illness or not, he no longer likes shrimp. In both Logue *et al.* (1981) and this study, subjects were asked to rate their certainty that the food in question caused nausea or vomiting. In both studies, a number of subjects showed strong aversions even though they knew that the food did not cause the symptoms. In contrast, we believe that someone afflicted with a shrimp allergy would be likely to gorge on shrimp if convinced that her allergy had been cured. Our evidence indicates greater acquired distaste in situations in which the subject is less confidence of a causal link between food and illness. However, this is probably the result of a higher incidence of nausea in uncertain situations.

The adaptive value of the special linkage between change in palatability and nausea is not apparent to us.

It would be natural to turn around and ask about the acquisition of likes for foods. Is there an "opposite" of nausea (perhaps satiation, or the termination of nausea) which is particularly effective in establishing likes for associated foods? The animal literature does not address this issue directly, since it has not distinguished between preferences resulting from acquired good tastes and anticipated beneficial consequences (Rozin, 1979). For humans, there is a fair amount of evidence suggesting that positive GI effects are not particularly effective in producing acquired likes (Pliner, Rozin, Cooper, & Woody, Note 2; Cines & Rozin, 1982), but Booth (1982) has reported that rapid satiation produces strong preferences (possibly good tastes) in animals and humans, and argues for the effectiveness of positive internal events. Especially in light of the fact that strong acquired likes are much more characteristic of humans than other organisms, one would be more inclined to look in the direction of cultural or social factors, and there is some evidence supporting their importance (Birch, Zimmerman, & Hind, 1980; Lepper, 1980).

Questionnaire data are extremely useful in that they allow for rapid collection of large amounts of information with no risk to subjects. However, the limitations of the questionnaire approach (especially when some of the data are retrospective) must also be considered. The events that subjects in the present study were asked to describe occurred a mean of 7·1 years prior to administration of the questionnaire, so that subject's reports of these events and the accompanying attitudes may be unreliable. The questionnaire contained an informal reliability check (see Method). However, in view of the results presented in this paper, reliability is not a problem. Low reliability, in the absence of bias, reduces the probability of obtaining a statistically significant result. So

it is reasonable to express concerns about reliability before an experiment is performed, since the use of a measure with relatively low reliability might preclude the identification of a real effect. It then follows that if a statistically significant effect is obtained with a measure that is thought to have low reliability, that the effect is real and that it might be even stronger than the data indicate.

Since these statements about reliability depend on the absence of bias, the possibility that biases were present must also be considered. Bias in these data seems unlikely. During informal discussions which took place with approximately one quarter of the subjects after they completed the questionnaire, no subject correctly identified the major hypothesis. Indeed, even when the hypotheses were explained, many of these subjects had difficulty in understanding them. The measure which was most likely to have been subject to forgetfullness (unreliability) or bias was pre-like. This is because it required not only recollection, but recollection of an attitude as opposed to a striking event (e.g., "I used to like the taste of that food" as opposed to "I regurgitated after eating that food."). However, the relationship between symptom and liking remained about the same whether post-like alone (which is not retrospective) or change in liking (post-like minus pre-like) was considered.

Since these data are also correlative, causal inferences must be carefully considered. The intuitively obvious intepretation of the results of this study is that the association of nausea with food causes the taste of the food to be disliked. However, it might be the case that current aversion to a food causes subjects to recall or invent nausea as the cause of the current dislike. In the absence of bias (see above) it is difficult to imagine why such retrospective invention would apply to nausea and not to other symptoms (e.g., headache). In fact, the data compellingly suggest that the symptom causes the change in liking. There are many hundreds (perhaps thousands; Garb and Stunkard, 1974; Logue *et al.* 1981; Rozin and Fallon, 1980 and the current paper) of recorded anecdotes of acquired aversions which are totally explicit about the order of events. Even more telling is the strong analogy between the work presented here and experiments done on rats by Pelchat *et al.* (Note 1), where the temporal course of events was observed. Nausea caused rats to behave as if they disliked the taste of sucrose, whereas shock did not.

We believe that we have documented a clearcut relation between a particular event (nausea) and a stable change in affective response to an associated object. We see this result as an early step towards understanding the "laws" of acquisition of affective responses.

Reference Notes

1. Pelchat, M. L., Grill, H. J., Rozin, P. & Jacobs, J. D. Quality of acquired responses to tastes depends on type of associated discomfort. Unpublished manuscript.
2. Pliner, P., Rozin, P., Cooper, M. & Woody, G. Role of medicinal context and specific postingestional effects in the acquisition of liking for the tastes of foods. (Manuscript).

References

Bernstein, I. L. Learned taste aversions in children receiving chemotherapy. *Science*, 1978, *200*, 1302–1303.

Bernstein, I. L., Vitiello, M. V., & Sigmundi, R. A. Effects of tumor growth on taste aversion learning produced by antitumor drugs in the rat. *Physiological Psychology*, 1980, *8*, 51–55.

Bernstein, I. L., & Webster, M. M. Learned taste aversions in humans. *Physiology and Behavior*, 1980, *25*, 363–366.

Birch, L. L., Zimmerman, S. I., & Hind, H. The influence of social-affective context on the formation of children's food preferences. *Child Development*, 1980, *51*, 856–861.

Bolles, R. C. Species specific defense reactions and avoidance learning. *Psychological Review*, 1970, *77*, 32–48.

Booth, D. A. Normal control of omnivore intake by taste and smell. In J. Steiner & J. Ganchrow (Eds.) *The determination of behaviour by chemical stimuli*. London & Washington: IRL Press, 1982.

Braveman, N. S. What studies on preexposure to pharmacological agents tell us about the nature of the aversion-inducing agent. In L. M. Barker, M. R. Best, & M. Domjan, (Eds.), *Learning mechanisms in food selection*. Pp. 511–530. Waco, Texas: Baylor University Press, 1977.

Cines, B. M., & Rozin, P. Some aspects of the liking for hot coffee and coffee flavor. *Appetite*, *3*, 1982, 23–34.

Coil, J. D., Hankins, W. G., Jenden, D. J., & Garcia, J. The attentuation of a specific cue-to-consequence association by antiemetic agents. *Psychopharmacology*, 1978, *56*, 21–25.

Coil, J. D., & Norgren, R. Taste aversions conditioned with intravenous copper sulphate: Attenuation by ablation of the area postrema. *Brain Research*, 1981, *212*, 425–433.

Gamzu, E. The multifaceted nature of taste aversion inducing agents: Is there a single common factor? In L. M. Barker, M. R. Best, & M. Domjan, (Eds.), *Learning mechanisms in food selection*. Pp. 477–509. Waco: Texas: Baylor University Press, 1977.

Garb, J., & Stunkard, A. J. Taste aversions in man. *American Journal of Psychiatry*, 1974, *131*, 1204–1207.

Garcia, J., & Ervin, F. R. Gustatory–visceral and telereceptor-cutaneous conditioning—Adaptation to internal and external milieus. *Communications in Behavioral Biology*, 1968, *1* (Part A), 384–415.

Garcia, J., Hankins, W. G., & Rusiniak, K. W. Behavioral regulation of the milieu interne in man and rat. *Science*, 1974, *185*, 824–831.

Garcia, J., & Koelling, R. A. Relation of cue to consequence in avoidance learning. *Psychonomic Science*, 1966, *4*, 123–124.

Garcia, J., Kovner, R., & Green, K. F. Cue properties versus palatability of flavors in avoidance learning, *Psychonomic Science*, 1970, *20*, 313–314.

Gleitman, H. Getting animals to understand the experimenter's instructions. *Animal Learning and Behavior*, 1974, *2*, 1–5.

Grill, H. J., Sucrose as an aversive stimulus. *Neuroscience Abstracts*, 1975, *1*, 525.

Grill, H. J., & Norgren, R. The taste reactivity test, I. Orofacial responses to gustatory stimuli in neurologically normal rats. *Brain Research*, 1978, *143*, 263–279.

Hinde, R. A., & Stevenson-Hinde, J. *Constraints on learning: limitations and predispositions*. New York: Academic Press, 1973.

Johnson, J. D., Kretchmer, N.,& Simoons, F. J. Lactose malabsorbtion: Its biology and history. *Advances in Pediatrics*, 1974, *21*, 197–237.

Johnston, T. D. Contrasting approaches to a theory of learning. *Behavioral and Brain Sciences*, 1981, *4*, 125–139.

Krane, R. V., & Wagner, A. R. Taste aversion learning with delayed shock US: Implications for the "generality of the laws of learning". *Journal of Comparative and Physiological Psychology*, 1975, *88*, 882–889.

Lamon, S., Wilson, G. T., & Leaf, R. C. Human classical aversion conditioning: Nausea versus electric shock in the reduction of target beverage consumption. *Behavior Research and Therapy*, 1977, *15*, 313–320.

Lepper, M. R. Intrinsic and extrinsic motivation in children: Detrimental effects of superfluous social controls. In W. A. Collins (Ed.) *Minnesota symposium on child psychology*, (Vol. 14). Pp. 155–214. Hillsdale, NJ: Lawrence Erlbaum Associates, 1980.

Logue, A. W. Taste aversion and the generality of the laws of learning. *Psychological Bulletin*, 1979, *86*, 276–296.

Logue, A. W., Ophir, I., & Strauss, K. E. The acquisition of taste aversions in humans. *Behavior Research and Therapy*, 1981, *19*, 319–333.

Meiselman, H., VanHorne, W., Hasenzahl, B., & Wehrly, T. *The 1971 Fort Lewis food preference survey*. Natick, MA: U.S. Army, Natick Laboratories, Pioneering Research Laboratory, 1972.

Nachman, M., & Hartley, P. L. Role of illness in producing learned taste aversion in rats: a comparison of several rodenticides. *Journal of Comparative and Physiological Psychology*, 1975, *89*, 1010–1018.

Peryam, D. R., Polemis, B. W., Kamen, J. M., Eindhoven, J., & Pilgrim, F. J. *Food preferences of men in the U.S. Armed Forces*. Department of the Army, Quartermaster Food and Container Institute for the Armed Forces, 1960.

Rescorla, R. A. *Pavlovian second order conditioning: Studies in associative learning*. Hillsdale, New Jersey: Erlbaum, 1980.

Revusky, S. Learning as a general process with an emphasis on data from feeding experiments. In N. W. Milgram, L. Krames & T. M. Alloway, (Eds.), *Food aversion learning*. Pp. 1–51. New York: Plenum, 1977.

Richter, C. P. Total self-regulatory functions in animals and human beings. *Harvey Lectures Series*, 1942, *38*, 63–103.

Rozin, P. Specific aversions as a component of specific hungers. *Journal of Comparative and Physiological Psychology*, 1967, *64*, 237–242.

Rozin, P. The selection of food by rats, humans and other animals. In J. Rosenblatt, R. A. Hinde, C. Beer, & E. Shaw, (Eds.), *Advances in the study of behavior* (Vol. 1). Pp. 21–76. New York: Academic Press, 1976.

Rozin, P. Preference and affect in food selection. In J. H. A. Kroeze, (Ed.), *Preference Behavior and Chemoreception*. Pp. 289–302. London: Information Retrieval Limited, 1979.

Rozin, P., & Fallon, A. E. Psychological categorization of foods and non-foods: A preliminary taxonomy of food rejections. *Appetite*, 1980, *1*, 193–201.

Rozin, P., & Fallon, A. E. The acquisition of likes and dislikes for foods. In J. Solms and R. L. Hall, (Eds.), *Criteria of food acceptance: how man chooses what he eats*. Pp. 35–48. Zurich: Forster, 1981.

Rozin, P., & Kalat, J. W. Specific hungers and poison avoidance as adaptive specializations of learning. *Psychological Review*, 1971, *78*, 459–486.

Seligman, M. E. P. On the generality of the laws of learning. *Psychological Review*, 1970, *77*, 406–418.

Shettleworth, S. Constraints on learning. In D. S. Lehrman, R. A. Hinde & E. Shaw (Eds.) *Advances in the Study of Behavior* (Vol. 4). Pp. 1–68. New York: Academic Press, 1972.

Young, P. T. Appetite, palatability and feeding habit: A critical review. *Psychological Bulletin*, 1948, *45*, 289–320.

Received 5 February, 1982; revision 9 June, 1982