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Lay American Conceptions of Nutrition: Dose Insensitivity, Categorical Thinking, Contagion, and the Monotonic Mind

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Two studies explored Americans' tendency to simplify nutrition information. Substantial minorities of separate samples of college students, physical plant workers, and a national sample considered a variety of substances, including some essential nutrients (salt and fat), to be harmful at trace levels. Almost half the respondents believed that high-calorie foods in small amounts contain more calories than low-calorie foods in much larger amounts. Many subjects classified foods according to a good/bad dichotomy, and almost all subjects confounded nutritional completeness with long-term healthfulness of foods. To account for these results, we suggest the following heuristics and biases: dose insensitivity, categorical perception, a "monotonic mind" belief (if something is harmful at high levels then it is harmful at low levels), and the magical principle of contagion.

Key words: nutrition, preferences, biases, food choice, risk, health

Americans are very concerned about their health and their diet. They are exposed to a steady stream of information about the harmful and protective effects of various foods and additives. Many are poorly prepared to assimilate this information and hence make unwise choices in terms of their own health goals. This lack of preparation is particularly clear in responses to information about very low risks; these are beyond the comprehension of most individuals and are the sort of information that no individual could ever have accumulated in a lifetime. There is no way that we could be biologically adapted to conceive of such small risks. Sometimes there is an overresponse to information about low risks, and at other times this information is ignored. Slovic (1985) and others have explored risk perception and concluded that lay judgments are strongly influenced by the dreadedness of an outcome, the observability and rapidity of effects, and the amount of perceived personal control over the threat.

Little, if any, attention is given to nutrition, epidemiology, probability, or risk analysis in educational systems, including college. As a result of being inadequately educated and bombarded with food/health risk information, many people, we believe, adopt simplifying strategies, or heuristics (Tversky & Kahneman, 1974), that make nutritional decisions easier.

We propose that two simplifying approaches to nutritional information are categorical thinking, or the assumption that foods are either good or bad for health, and dose insensitivity, or the belief that if something is harmful in high amounts it is also harmful in low or trace amounts. This produces a problem when high levels of essential nutrients such as salt and fat are associated, in the press and some lines of research, with negative long-term health outcomes.

In two studies, we explored the judgments of college student, national, and blue-collar worker samples regarding (a) general nutrition principles (e.g., "Although there are some exceptions, most foods are either good or bad for health"), (b) the relative healthiness of foods that contain a trace amount or are totally free of a variety of substances (e.g., salt, sugar, and fat), (c) caloric content (comparing small amounts of high-caloric-density foods with large amounts of low-caloric-density foods), and (d) the relation between the "healthiness" of a food and its nutritional completeness.

Study 1

Method

Participants

We distributed a questionnaire entitled "Health Beliefs About Food, Nutrition, and Chemicals" to three groups of participants. One group consisted of primarily freshman and sophomore students in introductory psychology courses at the University of Pennsylvania. Approximately 250 questionnaires were distributed in class on two different occasions, once in 1992 and once in 1993. One hundred eighty-four usable questionnaires (in which almost all of the questions were answered) were returned; the sample was 40% male, with a mean age of 19.1 years. Another 150 questionnaires were distributed to University of Pennsylvania physical plant employees by a plant supervisor. The employees were given $1.00 on return of these forms to the office from which they were

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distributed. We obtained 121 usable forms; the sample was 49% male, with a mean age of 39.0 years. Finally, we mailed 500 questionnaires to randomly selected adult Americans from a list purchased from a survey research firm. We received 81 usable returns; the sample was 66% male, with a mean age of 53.9 years.

Materials

We constructed and designed the questionnaire in accordance with principles set forth by Dillman (1978). The survey was completely anonymous. The cover page specified the general purpose of the study as "finding out how Americans feel about certain foods and certain chemicals."

In addition to demographic items, there were four categories of questions relevant to the present study. One was a set of statements with which participants indicated the extent of their agreement on a 5-point scale from *disagree strongly* (1) to *agree strongly* (5). The individual items are presented in conceptual order in Table 1.

The second category of questions addressed diets free of particular substances and used the same rating scale (Table 2). This section, which we refer to as the "X-free diet items," was introduced as follows: "For the next seven items, *a diet means all the food you will eat over a period of years. A pinch means a pinch every day.*" Seven questions followed asking if the participant believed that "a diet totally free of sugar [or fat, mercury, chocolate, cholesterol, meat, or salt] is healthier than a diet of the same number of calories that includes a pinch of sugar [or fat, mercury, chocolate, cholesterol, meat, or salt] every day."

A third set of questions, the "Y–Z diet items," was aimed at the same issues as the second set but approached them in a different way (Table 3). Participants were instructed, "In the next section, *diet* refers to what is eaten over a period of years. When something is described as being added to diet Y, assume that some starch is removed from the diet *so that there is no change in the number of calories.* Diet Y and Diet Z on any line have the same number of calories. We are only concerned with health, *not* with which diet you would like better. Use the scale above to rate which you believe is *healthier* for the average healthy person." The response scale was as follows: 1 = *Y is definitely healthier than Z,* 2 = *Y is probably healthier than Z,* 3 = *Y is about equally healthy as Z,* 4 =

Table 1
Percentages of Participants Who Agreed or Disagreed With General Health and Nutrition Statements

Statement	All participants	Students[a]	National sample[a]	Physical plant workers
Positive dose items				
A person cannot eat too many vitamins. (% who agreed)	21 (8)	16 (8)*/**	13 (3)***	33 (11)
A diet cannot have too much protein in it. (% who agreed)	19 (18)	20 (13)*	11 (19)**	25 (24)
General dose items				
If something can cause harm to the body in large amounts, then it is always better not to eat it even in small amounts. (% who agreed)	20 (8)	15 (8)*	18 (4)*	30 (11)
Some prescription drugs are harmful if they are taken in large doses but are not harmful if taken in small doses. (% who disagreed)	36 (9)	26 (7)***/***	46 (8)	46 (13)
Categorical general item				
Although there are some exceptions, most foods are either good or bad for health. (% who agreed)	40 (21)	34 (22)*/**	42 (28)	49 (16)
Categorical high-calorie foods				
One ounce of chocolate has fewer calories than 5 oz of bread. (% who disagreed)	45 (30)	43 (32)	46 (25)	46 (29)
A pint of cottage cheese has more calories than 1 tsp of ice cream. (% who disagreed)	31 (25)	30 (27)*	25 (18)*	38 (27)
A teaspoon of corn oil has fewer calories than a half teaspoon of pure animal fat. (% who agreed)	47 (31)	45 (36)**/**	52 (21)	49 (28)
Desert island food choice				
Percent who chose hot dogs or milk chocolate	7	9	4	6

Note. Responses were made on a 5-point scale from *disagree strongly* (1) to *agree strongly* (5). Numbers in parentheses are percentages of respondents who chose the neutral response *neither agree nor disagree* (3). Significance levels are all based on chi-squares. These are 2 × 5 in all cases except the desert food choice, which is a 2 × 2 chi-square (hot dog or chocolate vs. any other response).
[a]Refers to the significance of the difference between scores for group & the next group to the right (students vs. national or national vs. physical plant workers. /*, under students, indicates significance of the difference between students and physical plant.
*$p < .05$, **$p < .01$, and ***$p < .001$ for differences between neighboring separate sample columns.

Table 2
Percentages of Participants Who Agreed That a Diet Free of a Particular Substance Is Healthier Than That Same Diet With a Pinch of the Substance in It

Diet free of:	All participants	Students[a]	National sample[a]	Physical plant workers
Sugar	22 (24)	13 (22)*/**	30 (16)	27 (33)
Fat	31 (15)	25 (14)/**	31 (10)	40 (20)
Mercury	50 (29)	51 (31)	63 (20)*	40 (33)
Chocolate	36 (21)	35 (25)	39 (10)	37 (23)
Cholesterol	38 (18)	34 (16)*	45 (9)*	41 (26)
Meat	22 (17)	16 (18)/*	27 (8)	28 (22)
Salt	26 (16)	19 (16)***/***	27 (10)	37 (21)

Note. Responses were made on a 5-point scale from *disagree strongly* (1) to *agree strongly* (5). Numbers in parentheses are percentages of respondents who chose the neutral response *neither agree nor disagree* (3).
[a]* refers to the significance of the difference between scores for the group and the next group to the right (students vs. national or national vs. physical plant workers). /* under students indicates significance of the difference between students and physical plant workers.
$^{**}p < .01$. $^{***}p < .001$. (Significance levels are based on 2 × 5 chi-squares.)

Z is probably healthier than Y, and 5 = *Z is definitely healthier than Y.*

A series of items followed, with the target substance-free choice always listed as Diet Y and Diet Z always described as Diet Y plus something. Typically, each target substance was presented in three scenarios (three different Diet Zs): a trace amount, a small amount, and a large amount per day. Target substances were sugar, salt, beef, coffee, chocolate, aspirin, fat, and alcohol. For example, the trace-of-salt item read, "Diet Y: A diet with *no* salt; Diet Z: Diet Y with a pinch of salt *every day.*" The same pattern was followed for a few questions in which lifestyle (sun exposure or cigarette smoking) was substituted for diet, for example, "Lifestyle Y: A lifestyle with *no* exposure to the sun; Lifestyle Z: Lifestyle Y plus 1 hour on the beach in the bright sun, *every year*" (see Table 3).

The fourth category contained one question with a unique format: "Assume you are alone on a desert island for one year and you can have water and one other food. Pick the food that you think would be best for your health (never mind what food you would like). *Check the food you would pick.*" The choices were, in order, corn, alfalfa sprouts, hot dogs, spinach, peaches, bananas, and milk chocolate.

In the questionnaires distributed to most subjects, all of the questions about a diet free of X preceded the questions comparing Diets Y and Z. Also, for each substance queried about in the Y–Z framework, the questions moved from lowest amounts (e.g., "1 pinch salt/day) to higher and highest amounts (e.g., "1 teaspoon of salt a day," "5 tablespoons of salt a day." To control for order, we had 57 students complete a reverse-order questionnaire in which the Y–Z questions were asked first and amounts progressed from high to low.

Results

Order Effects

The order of presentation of items had no significant effects except for half (14) of the cases in the Y–Z diet choice format. These questions were ordered from low to high amounts in the original version and in the opposite order in the reversed version. There was no systematic difference across items in the reversed and original orders, so we combined the data from the two forms.

Results for the Combined Samples

Although there were some substantial differences between samples (as discussed later), we first report the combined results from all participants who completed the surveys (N = 386; see Tables 1–3). We do not suggest that this combined sample is representative of the United States, given that approximately half the subjects were college students and the return rate from the national sample was less than 20%. However, the combined results do represent samplings from three different groups of Americans.

The tables show the percentages of respondents who endorsed (agree slightly or strongly) or rejected particular statements, whereas the actual data for most questions involved a 5-point scale of agreement. The significance tests between samples are based on 2 × 5 chi-square analyses, whereas the data reported in the table are a condensation of the raw data into two categories. As a result, what may look like a small percentage difference may be significant by chi-square analysis, or vice versa.

Dose insensitivity: Responses to trace and low levels of nutrients and other substances. The trace substances can be divided into items for which a trace (or higher) amount is actually essential, that is, those for which the dose–effect curve is definitely not monotonic (fat and salt); those for which there is no reason to believe that a trace or very low level is harmful, whether or not high levels are (sugar, chocolate, aspirin, beef, and perhaps coffee and alcohol); and those for which an informed person might properly posit a monotonic increasing risk function (cigarettes, mercury, sunlight, and perhaps coffee and alcohol). As to the first category, 25% of respondents indicated that a salt-free diet with a pinch of salt daily is less healthy than a salt-free diet, and 26% held that a salt-free diet is healthier than a diet with a pinch of salt. Corresponding percentages for a drop of butter fat per day in an otherwise fat-free diet were 29% and 31%, respectively. Hence, a substantial minority of participants failed to recognize the essential (positive) value of salt and fat and seemed to think of them as toxins. Furthermore, very modest levels of these substances (1 tsp per day in an otherwise salt- or fat-free diet) that are well within basic nutritional requirements were viewed as unhealthy by approximately half the respondents (51% for salt, and 49% for fat). (Note that at a number of places in the questionnaire, it was emphasized that the caloric value of the diet was not affected by the various substitutions.)

In the Y–Z diet and X-free diet sections, several rather neutral items in low amounts were rejected: 26% and 22% of respondents, respectively, reject sugar as less healthy at the pinch level, 25% and 22%, respectively, rejected a bite of meat per day; and 40% and 38%, respectively, considered chocolate unhealthy at very low levels. About one third of the sample treated chocolate as a toxin.

For the items for which a monotonic case is probably

Table 3
Percentages of Participants Who Agreed That a Diet Lacking a Particular Substance (Diet Y) Is Healthier Than the Same-Calorie Diet With Varying Amounts of the Substance in It (Diet Z)

Diet Y is healthier than the same-calorie diet containing:	All participants	Students[g]	National sample[g]	Physical plant workers
Sugar				
1 pinch of sugar/day	26 (29)	17 (30)/**	30 (32)	38 (27)
1 tsp of sugar/day	40 (22)	33 (23)*/*	42 (23)	50 (20)
5 tbsp of sugar/day	73 (9)	73 (6)*/*	89 (4)**	64 (17)
Salt				
1 pinch of salt/day	25 (28)	15 (28)**/**	37 (30)	31 (28)
1 tsp of salt/day	51 (18)	42 (18)**/**	56 (25)**	52 (13)
5 tbsp of salt/day	80 (7)	85 (7)/*	85 (4)	69 (9)
Beef				
1 bite of beef/day	25 (32)	19 (30)/*	24 (41)	35 (29)
0.25 lb of beef/day	57 (16)	60 (15)	59 (16)	50 (18)
1.5 lb of beef/day	76 (9)	81 (10)/***	82 (10)**	65 (8)
Coffee				
1 drop of coffee/day[a]	45 (41)	37 (49)/**	46 (42)	54 (29)
1 cup of coffee/day	71 (18)	80 (13)*/*	61 (27)	64 (21)
5 cups of coffee/day	86 (4)	93 (3)*/***	89 (1)	73 (8)
Chocolate				
1 M&M/day	40 (44)	34 (52)/**	39 (43)	49 (34)
1 cup of chocolate pudding/day[b]	32 (58)	23 (70)/***	33 (57)	45 (42)
Aspirin				
1 aspirin/week	34 (34)	36 (33)	19 (39)*	40 (33)
1 aspirin/day	47 (20)	55 (18)**	34 (19)	44 (22)
8 aspirins/day	85 (4)	92 (2)/***	87 (4)	73 (8)
Fat				
1 drop of butter/day[c]	29 (36)	22 (39)/**	24 (44)*	42 (26)
1 tsp of butter/day	49 (18)	47 (17)	42 (24)	55 (16)
5 tsp of butter/day	79 (8)	83 (7)	82 (5)	70 (12)
Alcohol				
1 sip of alcohol/week[d]	35 (42)	30 (45)	35 (48)	41 (34)
1 glass of alcohol/week	48 (27)	51 (23)*	40 (37)	50 (25)
1 glass of alcohol/day	68 (10)	76 (10)*	61 (21)	62 (19)
Sun				
1 hr/year[e]	31 (31)	28 (31)	28 (29)	36 (31)
50 afternoons/year	63 (11)	65 (8)/*	68 (6)*	53 (19)
Cigarettes				
1 puff/month[f]	70 (23)	72 (27)/***	70 (23)	68 (18)
1 pack/month	86 (5)	92 (4)/**	88 (3)	77 (9)
1 pack/day	89 (3)	95 (1)/***	90 (0)*	79 (8)

Note. Responses were made on a 5-point scale from *Y is definitely healthier than Z* (1) to *Z is definitely healthier than Y* (5). Numbers in parentheses are percentages of respondents who chose the neutral response *Y is about equally healthy as Z* (3).
[a]Unsweetened coffee with caffeine. [b]Diet Y plus one cup of chocolate pudding in place of the vanilla pudding every day. [c]Alternative (Diet Y) was described as "A diet with no fat." [d]Diet Y plus one sip of an alcoholic drink (e.g., beer) every week. [e]Lifestyle Y plus 1 hour on the beach in the bright sun, every year. [f]Lifestyle Y plus 1 puff of a filter cigarette once a month. [g]* refers to the significance of the difference between scores for the group and the next group to the right (students vs. national or national vs. physical plant workers). /* under students indicates significance of the difference between students and physical plant workers.
$*p < .05$. $**p < .01$. $***p < .001$ (significance levels are all based on chi-squares).

inappropriate, levels of less healthy ratings for trace amounts were higher: 45% for a trace of coffee, 34% for a trace of aspirin, and 35% for a trace of alcohol. Finally, for items for which a good case for monotonic effects might be made, 31% rejected a trace of sun exposure; 70%, a trace of tobacco; and 50%, a trace of mercury.

In general, participants became more concerned about each substance as its level increased and showed some discrimination between more and less harmful entities.

Dose insensitivity: Insensitivity to high levels of exposure. Dose insensitivity was also seen in responses to the questions about positively regarded nutrients: 21% (for vitamins) & 19% (for protein) of respondents believed that one cannot consume too much of these substances (see Table 1).

Categorical perception and beliefs about risk and nutrition. The item that most directly addressed the issue of monotonic thinking about risk was the item that asserted that things harmful in large amounts should always be avoided, even in trace amounts. Twenty percent of all respondents agreed with this item. In a parallel item, 36% of respondents disagreed with the claim that useful prescription drugs can be harmful in high amounts. Providing direct evidence of use of the simplifying categorical heuristic, 40% of participants generally assented to the categorization of foods as good and bad.

Dose insensitivity: Confounding of caloric density with the amount of calories consumed. The tendency to use categorical thinking was documented in the three questions about caloric density. In each case, a small amount of a high-calorie substance was compared with a much larger amount of a less caloric substance and participants were asked which dose had more calories. This was intended to measure an informally observed inclination of some people on diets to think they cannot consume any amount of rich food whatsoever. In this study, 45% of participants thought that 1 oz of chocolate has more calories than 5 oz of bread, 31% thought that 1 tsp of ice cream has more calories than 1 pint of cottage cheese, and 47% thought that a half teaspoon of animal fat has more calories than 1 tsp of olive oil. These cases illustrate a confounding of high caloric density with other "negative" properties such as amount of animal fat and a tendency to believe that healthy foods such as olive oil and cottage cheese have an inherently lower caloric impact, independent of dose.

The conflict between sufficient and excess intake of dietary essentials. The questions about high levels of salt and fat versus salt- or fat-free diets asked respondents to choose between the absence of a dietary essential and what they saw as an excess of it. Respondents opted for absence rather than excess: 79% believed that 5 tsp of butter per day in a long-term fat-free diet (with no net increase in calories) is less healthy than no fat at all, and 80% believed that 5 tbsp of salt per day is less healthy than a no-salt diet. Respondents failed to recognize that salt and fat are dietary essentials and that too much salt or fat is better than none at all.

Confounding Healthfulness and Completeness

Healthfulness in the desert island scenario depends more on the completeness of a food's nutrient profile than on nonoptimal levels of specific macro or micro nutrients that may influence the incidence of degenerative diseases. We doubt whether, nutrients aside, humans could ingest enough calories on a spinach or alfalfa sprout diet. Although sufficient calories could be extracted from peach, corn, or banana, the resulting diet would be very low in fat and protein, and the supply of essential amino acids would be seriously unbalanced. Generally, animal products are more likely to contain all necessary nutrients, sufficient protein, and more optimal amino acid balance, which suggests that hot dogs would best support survival. The profile of hot dogs is improved by the fact that they often contain milk solids or cereals. The presence of milk in milk chocolate gives it substantial levels of high-quality protein and other nutrients. In general, it seems to us that the only choices that offer sufficient protein and an amino acid profile that might support life for a year would be hot dogs and milk chocolate. Vitamins A and C deficiency is a possible problem with either the milk chocolate or hot dogs, but this possibility is small in comparison to the certain serious problems with any of the other choices.

As shown in Table 4, among all participants the most popular desert island food was banana (42%), followed by spinach (27%), corn (12%), alfalfa sprouts (7%), peaches (5%), hot dogs (4%), and milk chocolate (3%). Only 7% of participants chose the two foods most likely to provide a complete diet. Poor performance on this item can be attributed to a confounding of either healthiness and completeness, or long-term and very long-term effects of diet.

Relations Among Items: Patterns of Consistency

One might expect that items that seemed to tap the same features of nutritional knowledge would correlate positively with one another. There was weak evidence in support of this prediction. With respect to overreaction to trace levels, responses to the beneficial or harmless trace items (among the X-free diet items) for salt, fat, cholesterol, sugar, meat, and chocolate showed a mean intercorrelation of .39. The responses to the Y–Z diet items reflecting beneficial or harmless amounts of salt, sugar, fat, beef, and chocolate showed a mean intercorrelation of .29.

The three generic items—good/bad foods, harm for low doses of things that are harmful in high doses, and harm for high doses of prescription items that are safe at low doses (Table 1)—were only weakly related. The harm and prescription items showed only a .05 correlation (opposite to the predicted direction). The good/bad item correlated, as predicted, .25 with the low-dose harm item and −.06 with the prescription item. A correlation of .33 was found between the two items measuring the idea that if it is good in low doses (e.g., vitamins and protein) then there is no upper limit to it. Finally, the three items that measured awareness of the distinction between caloric density and amount eaten showed a mean correlation of only .08 (corrected for sign, so that a

Table 4
Percentages of Respondents Who Chose Each of Seven Foods as the Sole Food for 1 Year on a Desert Island

Food	Students (n = 189)	Physical plant workers (n = 109)	National sample (n = 80)	Faculty (n = 23)	Students with oranges (n = 124)
Corn	12.2	5.5	18.8	19.2	10.5
Alfalfa sprouts	3.1	11.9	10.0	3.8	2.4
Hot dogs	5.8	1.8	2.5	34.6	16.9
Spinach	27.5	29.4	18.8	7.7	39.5
Peaches	6.3	4.6	3.8	0	2.4
Bananas	40.7	43.1	43.8	11.5	24.2
Milk chocolate	4.2	3.7	2.5	23.1	4.0
Hot dogs and milk chocolate	10.0	5.5	5.0	57.7	21.0

Note. The last column presents students' responses to the later, modified version of the question, which specified that oranges were available on the island in addition to the one food.

positive correlation means the same type of error for each item).

We created three combined variables: one from scores on the two items that measured beliefs about essential foods in excess (vitamins and protein), a second from scores on the three items regarding caloric density (chocolate, oil, and cottage cheese), and a third from the four items indicating a negative reaction to traces of essential elements (salt and fat, in two different formats). The correlations of these combined scores with each other and with each of four general questions were surprisingly low. Of the 21 correlations, only 3 exceeded .20, and all 3 were correlations with the generic single item about the harmfulness of low doses given the harmfulness of high doses.

Sample Differences

Tables 1–4 summarize the responses to all questions by sample. In most cases, percent scores refer to respondents' endorsing the "inappropriate" response where our knowledge of nutrition indicates an inappropriate response. For all of the Y–Z diet items, we scored responses as the percentage of respondents reporting that the substance- or activity-free regimen is healthier.

As mentioned earlier, the total sample comprised a national sample (probably unrepresentative and biased toward a higher level of education, given the less than 20% return rate), a sample of physical plant workers, and a sample of college students. One would expect the less educated physical plant workers to show less nutritional sophistication, and they did.

There were 17 items that had clear nutritionally correct answers (3 salt and 3 fat items from the Y–Z diet items, the fat- and salt-free diet items, and all questions in Table 1). The students performed significantly better than the physical plant workers on 11 of these items ($ps < .05$), and the plant workers performed better than the students on 1 question (recognizing that a high level of salt in the diet is better than no salt at all). The students performed better than the national sample on 6 of the 17 questions, and the national sample performed better than the students on 3 of the questions. The national sample performed significantly better than the physical plant sample on 6 questions.

For 10 items dealing with beliefs about harmless traces of nonessential substances (the sugar, beef, coffee, chocolate, aspirin, and alcohol items in the Y–Z diet section and the sugar, chocolate, cholesterol, and meat items in the X-free diet section), the main effect was superiority of the students' responses to the physical plant employees' responses (students performed significantly better on 7 items).

In general, the major effect was the predicted poorer performance of the physical plant sample.

Discussion

There are opportunities in this instrument for respondents to fail to understand or to reasonably misinterpret some of the items. This is especially true of the Y–Z diet items and X-free diet items. Pilot work suggested that the great majority of respondents understood these questions, however, and there was some internal evidence for this (some consistency in answering patterns).

It is also possible that respondents made assumptions about the questions contrary to what was indicated. For example, although we made clear that the additives were compensated so that comparable diets had the same number of calories, respondents may have ignored this information. For example, the drop of butter could have been construed as extra calories. Conversely, for salt, respondents may not have taken the statements "salt-free" and "with no salt" to mean the complete absence of salt, but rather may have understood them to mean the absence of *added* salt. However, although one can imagine a person construing the label "salt-free" to mean no added salt, this is much less likely for "fat-free" (a common nutritional label these days), and even less likely for "meat-free" and "chocolate-free."

Furthermore, given that only 51% of the respondents thought the mercury-free diet was healthier than a diet with traces of mercury, we suspect that the respondents' level of nutrition knowledge would not support artifactual interpretations based on sophisticated nutritional considerations.

We had some concern about the desert island question, because although we are confident that hot dogs or milk chocolate is the correct answer, understandable concerns about the deficiency in vitamins A and C of a diet solely of these foods, which might arise from nutritional sophistication, might have confounded responses. We designed the second study to respond to some of these concerns about interpretations of questions.

Study 2

To gain further understanding of the responses to this questionnaire, we adopted two strategies. First, we made a revised, briefer student questionnaire, which was more explicit about the complete absence of substances in the Y–Z diet and X-free diet sections. In addition, in the desert island section we stipulated that oranges were available, along with water and the single other food. Second, we obtained answers to a few items from the original questionnaire from nutritionally sophisticated respondents.

Method

Participants

We constructed two brief new questionnaires for students using questions and modifications of questions from the original questionnaire. We distributed them, in a randomly mixed form, to all students in an introductory psychology course; they completed the one-page instrument in class. Usable returns were obtained from 124 students for each of Forms 1 and 2.

A different third brief questionnaire was used with the nutritionally sophisticated sample. We received 23 usable returns out of approximately 50 questionnaires distributed to the faculty and staff of two nutrition and one medicine departments at three universities in the Northeast. Four returns were from professional nutritionists, and the remaining 19 were from medical or nutrition faculty.

Materials

Both student questionnaires repeated the three levels of questions on fat and salt in the diet in the Y–Z diet section and the questions about fat, meat, salt, and mercury in the X-free diet section of the original questionnaire. The instructions were the same in both versions and the same as in the original questionnaire, but the description of Diet Y was changed in Version 2 to emphasize the complete absence of the target substance. The description of the no-fat (salt) Diet Y in Version 2 was "DIET Y. A diet with *no* fat [salt]. That means not just added fat [salt], but a diet that contains absolutely no fat [salt] of any form at all." All of the X-free diet items in Version 2 were modified in the same way; for example, the item for fat read, "A diet totally free of fat (that is, containing no fat at all, NOT just no added fat) is healthier than a diet of the same number of calories that includes a pinch of fat every day." We made identical modifications on the meat, salt, and mercury items.

Version 1 (which had the original low-dose questions) also included a modified form of the desert food question, in which the only change was in the instructions: "You can have water, oranges that grow on the trees, and one other food." In other words, we added a source of vitamins A and C to the diet of water and one other food.

The faculty questionnaire included the original desert food item and a selection of some of the other items (see Table 5). Six Y–Z diet items (the fat and salt sets) were included on the questionnaire given to the nutrition faculty, and two X-free items (fat and salt) were included on the questionnaire distributed to the medical faculty.

Results

The Modified Student Questionnaire

The results, displayed in Table 5, indicate slight, generally nonsignificant shifts in the direction of more dose sensitivity in the responses to versions of the fat and salt items that emphasized the complete absence of these substances. The mean shift in dose sensitivity across all questions (except mercury) was 3.9 percentage points. The largest shift, 16

Table 5
Comparison of Student Data From Table 1, Results From Medical/Nutrition Faculty, and Results From a Corrected Survey Emphasizing Nutrient Absence

Nutrient	Students (Table 1)[a] (n = 184)	Medical/ nutrition faculty[a] (n = 23)	Students, original version (1) (n = 124)	Students, revised version (2) (n = 124)
Y–Z diet items (% who agreed that the nutrient-absent-diet is healthier)				
Fat				
1 drop butter/day	22	—	21	20
1 tsp butter/day	47	—	30	28
5 tsp butter/day	83	—	77	69
Salt				
1 pinch salt/day	15	13	22	20
1 tsp salt/day	42	52	46	30
5 tbsp salt/day	85	78	81	72
X-free items (% X-free healthier)				
Fat	25	10[b]	19	16
Salt	19	0[b]	19	18
Mercury	51	90[b]	61	65
Meat	16	10[b]	16	21
Although there are some exceptions, most foods are either good or bad for your health. (% who agreed)	34***	9	—	—
A pint of cottage cheese has more calories than a teaspoon of ice cream. (% who disagreed)	30***[c]	35	—	—
A teaspoon of corn oil has fewer calories than a half teaspoon of pure animal fat. (% who agreed)	45***	9	—	—
Percentage who did not choose chocolate or hot dogs as the single food on a desert island	90***/**	42***	—	79

[a]*** refers to the significance of the difference between students (data from Table 1) and medical/nutrition faculty, or medical/nutrition faculty and students completing the revised version. /** under students (Table 1) for the last (desert) item refers to the difference between the original Study 1 student sample and the Study 2 sample using the revised format. [b]Ten participants. [c]Although faculty had a slightly higher "wrong" percentage, when all five possible answers were taken into account in the 2 × 5 chi-square analysis, the faculty showed significantly more correct responses, because whereas 52% of them strongly agreed with the correct statement, only 16% of the students did.

$^{**}p < .01$. $^{***}p < .001$. (Significance levels are based on 2 × 5 chi-squares, except for desert island, which is based on 2 × 2 chi-square.)

percentage points, was for the midlevel dose (1 tsp) of salt per day: 46% of respondents who completed the original questionnaire considered this less healthy than a salt-free diet, compared with 30% of respondents who completed the modified version, $\chi^2(4, N = 248) = 7.614$, *ns*. The only two significant effects (both at the .05 level) were in opposite directions (see Table 5).

The responses of the 124 undergraduate students who completed the modified desert island food item (with oranges) can be compared with those of the original student sample in Table 4 columns 5 and 1. There was a marked reduction in the banana choice (now 24.2%), with spinach the predominant choice (39.5%) and hot dogs chosen a little more often (16.9%). For this group, milk chocolate or hot dogs were selected by 21.0% of subjects, a little more than twice the level of the comparable student sample.

Using the chocolate/hot dog versus vegetable/fruit dichotomy, the "orange" group showed significantly higher choices of animal foods than did the original student sample, $\chi^2(1, N = 313) = 7.246, p < .01$. We concluded that vitamin or related concerns may have influenced some respondents' choice of desert island food in the original sample; however, there was still a strong underrepresentation of the two most complete foods.

Results from the Medical and Nutrition Faculty and Professionals

The results from the medical and nutrition faculty (23 completed) were less clear than we had expected they would be. For the X-free diet items (with only 10 responders), the faculty showed lower percentages of incorrect responses on the three tested items (fat, salt, and meat) in comparison with the student sample who completed the same form they did (the original form) and even the students who completed the modified version; but because of the small sample size, none of these differences reached significance. For mercury, the faculty were more negative to the trace than any other group, more clearly differentiating between traces of nutrients and traces of toxins.

The results on the Y–Z diet salt items were less clear. The faculty had the lowest (13%) error rate on the pinch-of-salt item. However, they had a higher (52%) error rate on the teaspoon-of-salt item and were in the same range as the students for the highest dose (5 tbsp of salt/day). We cannot account for this peculiar result, especially given the results of the X-free diet version of the question, but we presume that some of the faculty assumed that "salt" meant added salt (this was supported by interview with 1 respondent).

As expected, significantly fewer of the faculty (9% vs. 34% of the students) endorsed the dichotomization of food into good and bad. Similarly, with respect to treatment of caloric density as a determinant of caloric intake independent of amount ingested, on one item (cottage cheese vs. ice cream) we obtained the expected result of significantly fewer erroneous responses among the professionals (9% vs. 45% of the students). On the other item (corn oil vs. animal fat), a surprising 35% of the faculty (vs. 30% of the students) gave an incorrect answer. Although this is puzzling, we are, to some extent, reassured by the fact that in spite of the lack of faculty–student difference, the faculty response was significantly different from the student response in the predicted direction (using chi-square analysis), in that 52% of the faculty *strongly* agreed with the correct statement, as opposed to only 16% of the students.

There was considerable disagreement among the medical and nutrition faculty members about the best single food to have on a desert island. However, in this small sample, 57.7% chose hot dogs or milk chocolate, in comparison with 10% of the original student sample who chose these foods (which itself scored higher than the national and physical plant worker samples). On the basis of the simple 2 × 2 chi-square analysis, hot dog/chocolate versus another choice, the medical nutrition faculty's higher preference for hot dogs or chocolate was significantly different from the students, $\chi^2(1, N = 212) = 6.053, p < .05$; the national sample, $\chi^2(1, N = 103) = 9.434, p < .01$; and the physical plant sample, $\chi^2(1, N = 132) = 13.636, p < .001$. The medical and nutrition sample selection of hot dogs and chocolate was notably higher (57.7%) than the student results (21.0%) on the modified question in which oranges were included.

Discussion

The results on the modified questionnaire given to students strongly suggest that the assumption that "salt-free" (for example) meant no *added* salt may have held for a small percentage of respondents in the other samples but did not account for the major part of the dose insensitivity effect. Similarly, the results for the desert island question with oranges added suggest it was not a sophisticated concern about vitamins that caused most subjects to reject hot dogs and milk chocolate as a lone food source on a desert island.

Although the results from the medical and nutrition faculty support most of our assumptions, there are aspects of these results that raise questions about the interpretation of some of the results from Study 1.

General Discussion

We identified a belief in a significant minority of respondents that if something is harmful in large amounts, it is also harmful in small amounts. We call this "dose insensitivity." Evidence for this came from both a direct question on this subject and responses about the undesirable health qualities of foods containing a trace or very small amount of a variety of nutrients.

We also identified a (perhaps related) tendency for people to dichotomize foods into those good for one's health and those bad for one's health and to accrete accessory good qualities (e.g., nutrient completeness and inherently low calorie load) to the "good" foods and accessory bad qualities to the "bad" foods. We see this set of findings as indicative of categorical thinking.

In most cases, only a minority of our sample gave what we consider an erroneous response; however, it was usually a substantial minority, more than 20% in almost all cases. The low positive correlations between items suggest that for most people, a judgment depends more on the particulars of the example and less on the application of a general principle (e.g., that the number of calories ingested equals the caloric density multiplied by the amount ingested) to a set of relevant cases. Furthermore, specific gaps in nutritional knowledge (e.g., that salt is a necessary nutrient) undoubtedly contributed to errors.

Generally, we found that more educated participants used the categorical or dose-insensitive heuristic less frequently than did less educated participants. This difference may result from the more educated respondents' greater specific information about nutrition, greater understanding of the basic principles of nutrition and the natural sciences in general, and perhaps better understanding of the questions. However, it is disconcerting that although the small sample of medical and nutrition specialists was much less inclined to use the dose insensitivity and categorical heuristics, these errors did appear frequently in this sample as well.

Another belief pattern that may explain some of the results can be referred to as the monotonic mind, that is, a general reluctance to accept the idea that low and high doses may have opposite effects. Dose–effect functions actually are monotonic for some risks, such as sun exposure, AIDS, and X-rays. For other items, such as coffee or alcohol, there may be some debate on this point. For substances such as meat and sugar, however, it is virtually certain that there are a wide range of levels in the diet that have insignificant health implications, with negative effects beginning, according to most sources, at high levels in the diet. Of course, for salt and fat, the function is definitely not monotonic: Low levels are essential and beneficial, and very high levels are harmful. Sometimes, the monotonic approach may be an effective heuristic. And it is quite possible that monotonic biases exist in some domains but not others.

We can account for dose insensitivity in two ways. One simply invokes categorical thinking; to make life easier, people may divide the food world (and the rest as well, perhaps) into good/safe and not good/unsafe.

A second account invokes the sympathetic magical law of contagion and can explain most of the findings we present here. This principle of human thought was originally described by Tylor (1871/1974), Frazer (1890/1959), and Mauss (1902/1972) to account for a pattern of beliefs in traditional culture. The law basically states that "once in contact, always in contact." When two objects come in contact, their essences are exchanged, so that each bears a permanent residue or memory of the other (Rozin & Nemeroff, 1990). For example, a person's hair or clothing or an item of food he or she has prepared or taken a bite from all contain a permanent essence of the person. The point about contagion critical to the issue at hand is that essence transfer seems to occur in almost "full form" after only brief contact, so that contagion is dose insensitive (Rozin & Nemeroff, 1990; Rozin, Nemeroff, & Markwith, 1992).

The law of contagion has been shown to be a significant part of thinking in American culture (Rozin, Millman, & Nemeroff, 1986; Rozin, Nemeroff, Wane, & Sherrod, 1989). Common examples are the fact that people are reluctant to consume a food if it has had even brief contact with a sterilized cockroach and are reluctant to wear the clothing of persons that they dislike or find offensive. Just as a brief contact of a glass of juice with a sterilized cockroach imparts "cockroachness" to the juice, it may be that a small amount of sugar added to a food imparts "sugarness" to the food.

Attitudes to AIDS illustrate what is probably contagion-based dose insensitivity in a graphic way (Rozin et al., 1992). In an unpublished survey of University of Pennsylvania students, we asked, "How many AIDS viruses do you think would have to enter your bloodstream to give you a 50% chance of contracting AIDS within 10 years?" Of 80 respondents, 39 responded one virus. Although we do not know the correct answer to this question, the number is surely orders of magnitude more than this. However, just as a single grain of sugar is perceived as fully embodying the properties and potency of sugar, dose insensitivity leads to the belief in exaggerated potency of a single virus.

The present results provide evidence that a significant minority of people hold categorical/dose-insensitive views about any risk and a majority hold such a view in some specific domain. These beliefs are quite domain specific. This suggests that a useful way to educate people in this area might be to show them that they follow dose insensitivity beliefs in some areas and violate them in others, with the hope of extending their existing dose-sensitive beliefs to new domains. Slovic, Kraus, and Malmfors (1989) pointed out a basic distinction between the way people think about medicines and the way they think about toxins. People deal frequently with medicines, for which the belief that low levels are safe and high levels are dangerous must be very common (e.g., for aspirin). It is likely that in the area of medicine and some other domains, people may be able to think in terms of dose, whereas they cannot or choose not to in other areas, such as potential toxins. There was only a slight tendency toward this in our data set, with respect to aspirin versus salt/sugar.

Although there are alternative interpretations of some of our findings, we believe the pattern of results found for both low levels of additives and categorical thinking is most susceptible to the interpretation we have offered. Further explorations of the phenomena we have described should include refinement of questions and creation of other question formats to more thoroughly eliminate alternative interpretations. Furthermore, given the public health significance of the issues in question, a large random sample of Americans should be surveyed with a revised questionnaire.

We suggest that the law of contagion predicts the dose insensitivity and categorical thinking we observed. It remains for further research to determine whether the contagion formulation is helpful in understanding responses to risks. There are properties of contagion other than dose insensitivity, including the idea that it is engaged by physical contact and leaves permanent effects. We have found these and other contagion properties to correspond to attitudes toward AIDS in many people (Rozin et al., 1992).

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