

False beliefs about fattening foods can have healthy consequences

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We suggested to 228 subjects in two experiments that, as children, they had had negative experiences with a fattening food. An additional 107 subjects received no such suggestion and served as controls. In Experiment 1, a minority of subjects came to believe that they had felt ill after eating strawberry ice cream as children, and these subjects were more likely to indicate not wanting to eat strawberry ice cream now. In contrast, we were unable to obtain these effects when the critical item was a more commonly eaten treat (chocolate chip cookie). In Experiment 2, we replicated and extended the strawberry ice cream results. Two different ways of processing the false suggestion succeeded in planting the false belief and producing avoidance of the food. These findings show that it is possible to convince people that, as children, they experienced a negative event involving a fattening food and that this false belief results in avoidance of that food in adulthood. More broadly, these results indicate that we can, through suggestion, manipulate nutritional selection and possibly even improve health.

false memory | nutritional selection | food preferences | suggestion

What if your first taste of a fattening food, like strawberry ice cream, had caused queasiness? Might you avoid strawberry ice cream now? Although we cannot change the past, we can change how people remember the past. The present work shows how changing memory also can change behavior.

False Memories: A Primer

Memory can be distorted for the details of an event, as revealed by hundreds of studies (1). Before the mid 1990s, most work on memory distortion focused on memory for details. These included memory for words or pictures. In some instances, the details of memory for complex events were altered by suggestion, such that, for example, a person who saw a car go through a stop sign could be persuaded to remember that it was a yield sign (2).

In more recent work, investigators have demonstrated that entire events can be planted in memory, producing what we call “rich” false memories (3). In early studies involving rich false memories, people were led to believe that as children they had been lost in a shopping mall for an extended period, that they had been hospitalized overnight for an ear infection, or that they had spilled a punch bowl on the bride’s parents at a wedding (4, 5). These are events that would have been somewhat unusual or upsetting if they had actually occurred.

One potential problem with such work is that it is difficult to prove that these events did not occur in one’s childhood. To remedy this, investigators turned to highly improbable events. In one study, subjects were led to believe that they had witnessed a demonic possession as children (6). In another study, subjects were led to believe that a skin sample had been removed from their finger as part of a routine medical procedure, when, in fact, medical records showed that no such procedure had ever occurred (7). The typical procedure used in these studies is to tell subjects (falsely) that, as children, they had experienced a critical

life event (e.g., witnessing a demonic possession). After trying to imagine the critical event in question, many subjects come to embrace it as their own.

The Consequences of False Belief

Thus, past work shows that it is entirely possible to create rich false beliefs and memories, not only about childhood but also about recent experiences. But do these falsehoods have repercussions? Can they change attitudes or influence behaviors? We developed a procedure for examining the present-day effects of false childhood memories and beliefs. We falsely told experimental subjects that, as children, they had become ill after eating a certain food. We accomplished this in one study by specifically suggesting to some subjects that they had become ill after eating dill pickles and to other subjects that they had become ill after eating hard-boiled eggs (8).

How do you make people believe that they had become ill after eating a particular food? Our method involved a variation of the false-feedback technique (9). In false-feedback studies, the investigator gathers data from subjects and then plies them with misinformation about the meaning of their data (10, 11). In our particular version of the false-feedback technique, we gathered a mass of data from subjects and later told them that their individual data had been analyzed by a sophisticated computer and a profile of their early childhood food experiences had been generated. To lend credibility to the feedback, this profile contained a few filler items that we believed would be true of most children (e.g., you disliked spinach). The profile also contained the critical item (e.g., “you got sick after eating hard-boiled eggs/dill pickles”). We asked subjects to spend a few minutes contemplating their feedback.

We found that the false feedback increased participants’ confidence that the critical event had occurred (e.g., false feedback about dill pickles made people believe that they had become ill after eating dill pickles). In terms of repercussions, we also found that those who believed the false suggestion (the believers, who comprised $\approx 30\%$ of subjects) later avoided the critical food. By avoid, we mean that they told us that they were less inclined to want to eat the food at a party, and, more generally, they told us that they enjoyed the food less (8). These findings were among the first to suggest that false food memories can be created, and that those false memories might have behavioral consequences.

The Present Study: Fattening Foods

Could we convince people that they had had a negative experience with a fattening food as a child, and in turn, find that they avoid that food now? Armed with the knowledge that we could create false food memories for dill pickles and hard-boiled eggs and observe avoidance of these foods, we turned our attention

See accompanying Profile on page 13721.

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to foods that people would be better off avoiding for health reasons. We conducted two experiments to determine whether we could convince subjects that they had had a negative childhood experience with chocolate chip cookies (Experiment 1) or strawberry ice cream (Experiments 1 and 2).

In pilot work, we were unable to make people avoid eating potato chips by using our false-feedback procedure. We wondered whether our subjects' steadfast consumption of potato chips, even when they falsely believed that they had become ill after eating potato chips as children, stemmed from the fact that potato chips are an all-too-common snack. Perhaps our false food-feedback technique would lead to food avoidance only with novel foods. The taste-aversion literature offers support for this notion. Real taste aversions develop more readily with novel foods (12). To test the hypothesis that our false-feedback procedure would work best on a novel food, in Experiment 1 we used a more novel fattening food (strawberry ice cream) and a less novel one (chocolate chip cookie).

Experiment 1

Method. Subjects. The subjects were 131 undergraduates at the University of Washington, who received course credit for their participation. We randomly assigned subjects to one of three groups: strawberry ice cream ($n = 47$), chocolate chip cookie ($n = 44$), and controls ($n = 40$). Subjects participated in groups. Group size was determined simply by how many subjects showed up to participate in any given experimental session. Thus, sometimes the group was small (e.g., $n = 2$) and sometimes much larger, nearly filling the experimental room, which held a maximum of 30 subjects.

Materials and procedure. Subjects signed up for a study called "Food and Personality" and completed six questionnaires during session 1 and five questionnaires during session 2 (separated by 1 week). Questionnaires were administered in a fixed order. During session 1, subjects completed a 24-item Food History Inventory containing two critical events: "Felt ill after eating strawberry ice cream" and "Got sick after eating a chocolate chip cookie" in positions 9 and 16, respectively. Subjects rated items on a scale ranging from 1 (definitely did not happen before 10 years of age) to 8 (definitely did happen before 10 years of age). Subjects also completed a 64-item Food Preferences Questionnaire in which they rated how much they liked to eat various foods, including strawberry ice cream and chocolate chip cookies. Finally, subjects completed a Party Behavior Questionnaire involving an imaginary party with various foods and beverages available. Subjects indicated their likelihood of consuming each of 37 options, including the two critical items, strawberry ice cream and chocolate chip cookies. Subjects used an 8-point scale to complete the Food Preferences Questionnaire and the Party Behavior Questionnaire, where low scores indicate unwillingness to eat or lack of interest in eating each food choice. We interspersed three filler questionnaires within these three questionnaires to disguise our hypotheses and make the subsequent manipulation seem more credible. These filler questionnaires included two personality measures and an eating-habits measure.

During session 2 (exactly 1 week later), subjects received false feedback about their responses to the questionnaires that they had completed during session 1. We falsely told subjects that we had entered their responses into a computer that, in turn, had generated a profile of their early childhood experiences with certain foods. We presented these profiles as if they had been tailored individually to each subject. We told all subjects that, as young children, they disliked spinach, enjoyed eating bananas, and felt happy when a classmate brought sweets to school. Additionally, strawberry ice cream subjects received the critical item, "You felt ill after eating strawberry ice cream," and chocolate chip cookie subjects received the critical item, "You

got sick after eating a chocolate chip cookie." Control subjects received no feedback about the critical items. To ensure that subjects thought about this feedback, we told experimental subjects that the computer randomly selected two feedback items for them to elaborate on. The first was a filler item (classmate brought sweets to school), and the second was the critical item. Controls were told that the computer randomly selected a single item and responded only to the filler item. For each item, subjects then answered the question "To what extent do you feel that this event is reflected in your personality today?" by using a scale of 1 (not at all) to 8 (very much). The next question asked: "How is your personality different because of this event? (For example, are you more timid? More sociable? Happier?)" A space was provided for a free response. We designed these questions to bolster our cover story that we were interested in studying food and personality.

Subjects then completed the Food History Inventory, the Food Preferences Questionnaire, and the Party Behavior Questionnaire for the second time. This procedure permitted us to track changes in subjects' responses from pre- to postfeedback. Finally, subjects completed a memory/belief form in which they answered questions pertaining to three items from the Food History Inventory, including the critical item ("Got sick after eating a chocolate chip cookie" for the chocolate chip cookie and control group; "Felt ill after eating strawberry ice cream" for the strawberry ice cream group). We asked subjects to indicate whether they (*i*) had "a specific memory for the event (from before the age of 10)" and, if so, to "write as many details as possible about the memory"; (*ii*) had a belief "that the event happened [before the age of 10], but [without] a specific memory"; and, if so, to "explain why you think the event happened to you"; or (*iii*) were "positive that the event did not happen to you before you were 10"; and, if so, to "explain how you are so sure that the event didn't happen." At the end of the memory/belief form, subjects wrote what they thought the purpose of the study was. This open-ended question permitted us to determine whether any subjects correctly guessed the purpose of the study and to address the issue of demand characteristics.

Results. Feedback and confidence. All statistical tests are one-tailed, unless otherwise mentioned. Did false feedback about getting sick after eating the critical foods affect participants' confidence that it had actually happened? The relevant data appear in Fig. 1 for the pre- and postfeedback ratings on the Food History Inventory. As shown in Fig. 1A, subjects who received false feedback about strawberry ice cream increased their confidence that they had felt ill after eating this food as children, moving from an average rating of 2.49 to an average rating of 3.0. Controls did not increase on this item. Moreover, as shown in Fig. 1B, subjects who received false feedback about a chocolate chip cookie did not increase their confidence that they had gotten sick after eating this food as children.

To test for statistical significance, we conducted within-subject *t* tests on the pre- and postfeedback data. The increase in Food History Inventory responses approached significance for the strawberry feedback condition [$t(44) = 1.50, P = 0.071$] but was clearly not significant for the chocolate chip feedback condition ($t < 1.0$).

Of course, the increase in confidence about feeling ill after eating strawberry ice cream includes those who believed in the feedback and those who did not. It is of interest to ask how much those who fell sway to the suggestive feedback increase their confidence. Determining who is a believer is a bit arbitrary, but we have settled on a reasonably conservative definition (13). We define believers as those who (*i*) entered the experiment rather confident that the critical event had not happened to them (i.e., they gave an initial Food History Inventory rating of 1–4), (*ii*)

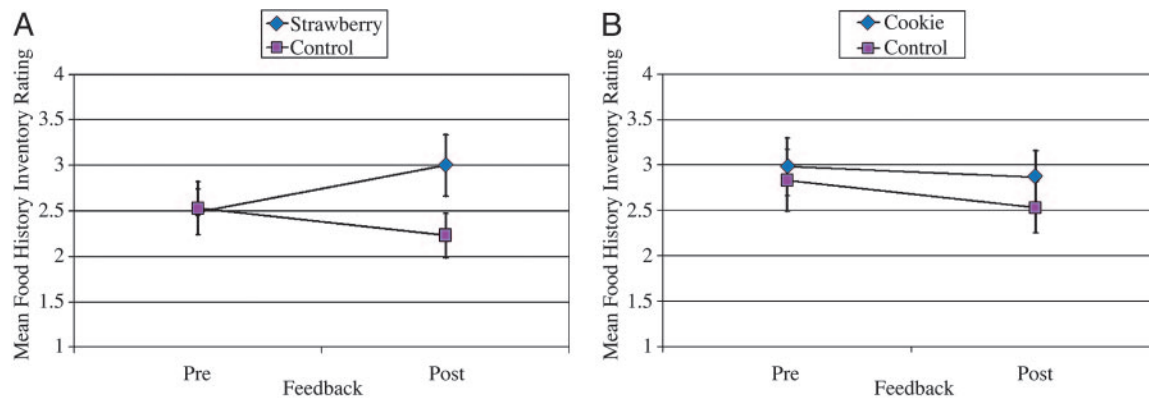


Fig. 1. Mean confidence ratings that subjects “felt ill after eating strawberry ice cream” (A) or “got sick after eating chocolate chip cookies” (B) as children, both pre- and postfeedback, in Experiment 1. Ratings were made on a scale of 1 to 8. Error bars represent standard errors of the mean.

increased by at least one point after feedback, and (iii) later reported on the memory/belief form that they either remembered or believed the event had happened. Of the 39 individuals who started reasonably confident that the strawberry ice cream event had not happened, 7 (18%) increased their confidence and reported a subjective memory or belief of the experience. For purely descriptive purposes, we report the magnitude of subjects’ increase in confidence that the event happened: Believers moved from 1.57 to 5.57, an increase of 4 points. Nonbelievers (i.e., those subjects not meeting the three criteria for the definition of believers) showed no increase (2.09–2.09). Thus, the believers increased an average of 4 points on the 8-point scale, quite a sizable jump.

Food avoidance. Next, we asked whether the false feedback led subjects to avoid the critical food. We first explored how much subjects claimed to like to eat strawberry ice cream. Overall, subjects who received false feedback preferred strawberry ice cream less on the Food Preferences Questionnaire: Their ratings dropped significantly [from 6.05 to 5.53; $t(39) = 2.82, P < 0.01$]. Controls did not drop significantly (from 6.21 to 6.03; $t = 1.0$). A similar pattern emerged on the Party Behavior Questionnaire, with strawberry ice cream subjects dropping from 5.88 to 5.23 [$t(42) = 2.29, P = 0.014$], and controls remaining unchanged (from 5.60 to 5.58; $t < 1.0$). Thus, the strawberry ice cream feedback clearly led to self-reported avoidance of the food.

For the chocolate chip cookie item, subjects who received false feedback preferred chocolate chip cookies less on the Food Preferences Questionnaire after receiving the feedback [a drop

from 6.77 to 6.42; $t(42) = 1.78, P = 0.042$]. In contrast, these subjects’ ratings on the Party Behavior Questionnaire were unaffected by the cookie feedback (a score of 6.23 both pre- and postfeedback; $t < 1.0$). Controls did not drop significantly on either the Food Preferences Questionnaire or the Party Behavior Questionnaire ($P > 0.20$ for both).

However, the overall data include both those who fell sway to the manipulation and those who did not. Thus, we separately examined subjects’ responses to the Food Preferences Questionnaire and Party Behavior Questionnaire for believers, nonbelievers, and controls. These data appear in Table 1. We computed these values by including subjects who began the study relatively confident that the critical event had not occurred in their childhood (i.e., Food History Inventory ratings of 1–4). The first thing to notice is that the strawberry ice cream believers consistently avoided (or did not prefer) strawberry ice cream. They dropped from mean ratings of 5.17 to 4.33 on the Food Preferences Questionnaire and from 4.86 to 4.29 on the Party Behavior Questionnaire. We calculated an overall avoidance score by first calculating a difference score for each subject on each of the avoidance measures. We then averaged the two difference scores. The overall avoidance scores appear in the rightmost column of Table 1, with higher scores indicating greater avoidance. So, here one can see that the strawberry ice cream believers appear to be avoiding the food more than nonbelievers and controls, but that is not the case for the chocolate chip cookie believers. Because of the small number of believers in the two experimental groups, we did not perform analyses on these data.

Table 1. Mean ratings of items on the Food Preferences Questionnaire (on a 1–8 scale) and the Party Behavior Questionnaire (on a 1–8 scale), split by whether participants believed the relevant feedback (believers), did not believe it (nonbelievers), or were not exposed to it (controls) in Experiment 1

Experimental group	Prefeedback	Postfeedback	Prefeedback	Postfeedback	Overall avoidance
	Prefer	Prefer	Party	Party	
Strawberry ice cream					
Believers ($n = 7$)	5.17	4.33	4.86	4.29	0.71
Nonbelievers	6.28	5.90	6.32	5.77	0.42
Controls	6.24	5.97	5.60	5.46	0.21
Chocolate chip cookie					
Believers ($n = 4$)	7.50	7.00	7.00	7.25	0.13
Nonbelievers	6.64	6.14	5.93	5.93	0.25
Controls	6.90	6.67	6.07	5.77	0.27

Overall avoidance is calculated as the average difference between pre- and postfeedback on the Food Preferences Questionnaire and Party Behavior Questionnaire. Positive avoidance values denote more avoidance. Prefer, Food Preferences Questionnaire; Party, Party Behavior Questionnaire.

Memory or belief? One issue that we have not yet addressed is whether the believers simply believed that they had felt ill after eating strawberry ice cream, or whether they actually developed a concrete recollection of the experience. Of the strawberry ice cream subjects, recall that seven (18%) met the definition of believers. Of those, only one (14%) remembered the event (that is, chose “memory” on the memory/belief form), and the remainder just believed that it had happened. For the chocolate chip cookie group, none of the four believers remembered the event. Thus, the vast majority of believers simply believed that the event had occurred.

Purpose of study. We used a 4-point scale to code subjects’ open-ended responses regarding the study’s purpose. To obtain a score of 0, the subject had to report something unrelated to the study’s true purpose (e.g., personality and food). To obtain a score of 1, the subject had to report something about memory (e.g., memory test, “if memory can be influenced”). To obtain a score of 2, the subject had to report either about false memory or food preference being influenced by childhood (e.g., “how childhood affects food preferences,” “if food and memory are related”). To obtain a score of 3, the subject had to mention both false memory and its relation to food preference. No subject received a score of 3. Two subjects in the strawberry ice cream group, two subjects in the chocolate chip cookie group, and seven subjects in the control group received a score of 2. The overall data pattern did not change when we removed these subjects from the analyses.

Discussion. Experiment 1 demonstrates that it is possible to lead a substantial minority of people to believe that, as children, they had felt ill after eating a fattening food (strawberry ice cream). Before our manipulation, they had denied this. After the manipulation, nearly 20% of subjects came to believe that they had the experience we suggested to them. More importantly, this newfound autobiographical belief was accompanied by the intent to avoid strawberry ice cream in adulthood. We also showed that among those who believed in the false feedback, the large majority of them claimed that they believed the event had occurred but did not indicate that they had a concrete recollection of it. Although we succeeded at leading a few people to believe that, as children, they had felt ill after eating strawberry ice cream, we could not lead people to believe that, as children, they had gotten sick after eating a chocolate chip cookie.

The fact that we succeeded with the strawberry ice cream item but not the chocolate chip cookie item in Experiment 1 lends support to the idea that our false-feedback procedure works better on novel foods than on common foods. Of course, this argument rests on the assumption that strawberry ice cream is more novel than chocolate chip cookies. Support for this assumption comes from the fact that when we collapse across group and across the Food Preferences Questionnaire and the Party Behavior Questionnaire, subjects preferred and reported more willingness to eat chocolate chip cookies than strawberry ice cream both before [$t(128) = 3.04, P < 0.01$] and after [$t(127) = 3.81, P < 0.01$] the false-feedback manipulation.

We designed Experiment 2 to replicate and extend the effects that we observed in Experiment 1. First, we retained the strawberry ice cream item from Experiment 1. Next, we tried to increase the number of people who believed that they had become ill after eating strawberry ice cream as children. To do this, we used the same false feedback that we used in Experiment 1, but added an elaboration task. We reasoned that deeper processing of the critical feedback, in the form of imagination, might produce stronger effects (14). Moreover, we explored whether the particular way in which one elaborated on the false feedback mattered. We used two different methods of false feedback to test this idea.

Another purpose of Experiment 2 was to investigate the

possibility that the cookie item did not work in Experiment 1 because people eat cookies too frequently and may have even eaten them recently. Perhaps eating a food frequently or recently produces many positive experiences or a strong recent positive association, and one negative suggestion will not counteract this mass of positive experience. This analysis suggests that people who have eaten strawberry ice cream recently might be less inclined to show the false belief and avoidance effects, compared with those who have not. We included a new instrument to assess the recency of having eaten several foods, including strawberry ice cream.

Experiment 2

Method. Subjects. Subjects were 204 undergraduates at the University of Washington, who completed both sessions of the experiment. They received course credit for their participation. We randomly assigned subjects to one of three groups: strawberry ice cream elaboration ($n = 71$), strawberry ice cream scenario ($n = 66$), and controls ($n = 67$). Subjects participated in groups as in Experiment 1.

Materials and procedure. The materials and procedures were nearly identical to those in Experiment 1. Briefly, subjects completed six questionnaires during session 1 and five questionnaires during session 2 (separated by 1 week). During session 1, subjects completed the Food History Inventory containing only a single critical item: “Got sick after eating strawberry ice cream” in position 16. Subjects also completed the Party Behavior Questionnaire and Food Preferences Questionnaire, both of which included the critical item “strawberry ice cream.” Subjects completed a Recent Food Experiences Questionnaire, in which they reported the last time they had completed 17 food-related activities (e.g., ate breakfast; went on a diet) on a 7-point scale: never, today, yesterday, days ago, weeks ago, months ago, years ago. One of the 17 items, “ate strawberry ice cream,” allowed us to determine whether our effects related to one’s recent experience with strawberry ice cream. In addition to these four measures, subjects completed two filler questionnaires.

During session 2, which occurred 1 week after session 1, subjects received false feedback about their responses to the session 1 questionnaires (see *Appendix*). We falsely told them that, based on their responses, a computer program had generated a profile of their early childhood experiences with certain foods. These seemingly individually tailored profiles told all subjects that as young children they disliked spinach, enjoyed eating pizza (instead of the “enjoyed eating bananas” item that was used in Experiment 1), and felt happy when a classmate brought sweets to school. Additionally, the strawberry ice cream subjects received the critical item “Got sick after eating strawberry ice cream.” The profile instructed strawberry ice cream elaboration subjects to elaborate on the feedback by considering the item “Got sick after eating strawberry ice cream” from their profile. Specifically, the profile stated: “Think about your memory of this experience. If you don’t have a specific memory, imagine what might have happened. Then answer the following questions, in some detail. . . .” The profile contained follow-up questions explicitly designed to encourage elaboration: “How old were you?” “Where did it occur? And what were you doing at the time?” “Who were you with?” and “How did it make you feel?” For the strawberry ice cream scenario subjects, the profile asked them to consider two possible scenarios and pick the one that best matched their memory of their own experience. One scenario concerned a friend’s birthday party and the other a family experience at a restaurant. The profile stated that if subjects did not have a specific memory, they should pick the scenario that was closest to what they thought might have happened. At the end of all three versions of the false feedback, we asked subjects to complete a Software Follow-Up Questionnaire that stated: “We are still working to improve our software

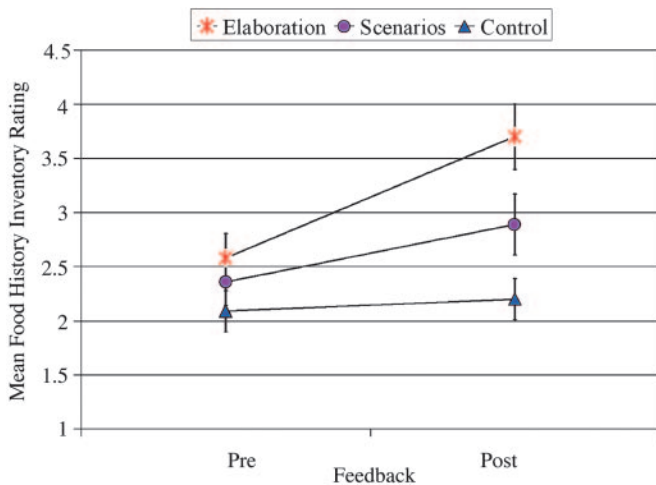


Fig. 2. Mean confidence ratings that subjects “got sick after eating strawberry ice cream” as children, both pre- and postfeedback, in Experiment 2. Elaboration subjects answered additional questions about the critical strawberry ice cream event. Scenario subjects selected one of two descriptions of an occasion when the critical event might have happened. Control subjects did neither. Ratings were made on a scale of 1 to 8. Error bars represent standard errors of the mean.

program. To assist us in this process, please complete the following. What is the most important childhood, food-related event that your food profile did not report? Please explain in the space below.” Again, we designed this questionnaire to encourage subjects to process the feedback; however, we were not interested in subjects’ responses to this question.

Subjects then completed the Food History Inventory, Food Preferences Questionnaire, and the Party Behavior Questionnaire for the second time. Finally, subjects completed a memory/belief form in which they answered questions pertaining to three items from the Food History Inventory, including the critical item (“Got sick after eating strawberry ice cream”). At the end of the memory/belief form, subjects wrote what they thought the purpose of the study was.

Results. Feedback and confidence. All statistical tests are one-tailed unless otherwise mentioned. Did false feedback about getting sick after eating strawberry ice cream affect subjects’ confidence that the event happened in childhood? As can be seen in Fig. 2, both the elaboration and scenario experimental subjects increased their confidence that they had gotten sick. The elaboration condition produced the largest increase, moving from a mean of 2.58 to 3.70 on the Food History Inventory (an increase of more than a full point on the 8-point scale). Controls remained nearly flat.

To test for statistical significance, we conducted within-subject *t* tests on those subjects who provided both pre- and postfeedback data. The increase in Food History Inventory responses was significant for both the elaboration subjects [$t(70) = 3.97, P < 0.01$, and the scenario subjects, $t(65) = 2.10, P = 0.025$]. Controls did not increase significantly, $t < 1.0$.

Next, we examined our data in terms of believers and nonbelievers. We defined believers as in Experiment 1: Subjects who provided a confidence rating between 1 and 4 for the strawberry ice cream item on the first Food History Inventory, who later increased their confidence on this item on the second Food History Inventory, and who reported either a memory or a belief for this critical event. By this conservative definition, the elaboration manipulation produced the most believers [$\chi^2(1,116) = 4.80, P = 0.014$]. The elaboration subjects began with 71 subjects, of whom 58 provided an initial low Food History Inventory

rating (1–4). Of those 58, 24 (41%) met the definition of believers in that they increased on the Food History Inventory and claimed to have a memory/belief that they had gotten sick after eating strawberry ice cream. For the scenario manipulation, the group began with 66 subjects, of whom 58 provided an initial low Food History Inventory score. Of those 58, 13 (22%) met the definition of believers. Of the 67 controls, 59 started low, and of these, only 3 (5%) met the definition of believers. For purely descriptive purposes, we report the magnitude of subjects’ increase in confidence that the critical event happened: the 24 elaboration believers increased from 2.08 to 5.79, or nearly 4 points. The 13 scenario believers increased from 2.08 to 5.23, or well over 3 points. As so defined, the nonbelievers showed no meaningful increase in either group (1.74–1.56 for the elaboration subjects and 1.76–1.84 for the scenario subjects).

Food avoidance. Next, we asked whether the false feedback led subjects to avoid strawberry ice cream. To see this, we explored how much they preferred to eat strawberry ice cream on the Food Preferences Questionnaire. Overall, subjects who received false feedback claimed to enjoy strawberry ice cream less. The decrease on the Food Preferences Questionnaire from 5.37 to 5.08 approached significance for the elaboration subjects [$t(70) = 1.57, P = 0.061$] but was significant for the scenario subjects, a drop from 5.89 to 5.45 [$t(65) = 2.11, P = 0.020$]. Controls did not drop at all; in fact, they increased slightly from 5.52 to 5.69 [$t(66) = 1.06, P > 0.15$]. Our other measure of subjects’ tendency to embrace the critical food was the Party Behavior Questionnaire. Overall, subjects who received false feedback were less inclined to want to eat the critical food at a hypothetical party. Elaboration subjects dropped from 5.25 to 4.99, a nearly significant drop [$t(70) = 1.56, P = 0.062$]. Scenario subjects dropped from 5.59 to 5.21, which was significant [$t(65) = 1.88, P = 0.032$]. Inexplicably, Controls also dropped significantly on this measure, from 6.0 to 5.68 [$t(65) = 1.83, P = 0.037$].

However, the overall data combine those who fell for the manipulation and those who did not. Thus, we separately examined subjects’ responses to the critical item on the Food Preferences Questionnaire and Party Behavior Questionnaire for believers, nonbelievers, and controls. These data appear in Table 2. As in Experiment 1, we computed these values by including subjects who began the study relatively confident that the critical event had not occurred in their childhood (i.e., Food History Inventory ratings of 1–4). The first thing to notice is that believers exposed to either feedback manipulation consistently avoided (or did not prefer) strawberry ice cream. We calculated an overall avoidance score by first calculating a difference score for each subject on each of the avoidance measures. We then averaged the two difference scores. The overall avoidance scores appear in the rightmost column of Table 2, with high scores indicating greater avoidance. Thus, one can easily grasp that the believers are avoiding more than the nonbelievers and controls, as evidenced by a significant one-way analysis of variance on the overall avoidance scores [$F(2,180) = 4.08, P = 0.019$, two-tailed]. Follow-up tests on the simple effects, by using a Bonferroni correction for two-tailed tests, revealed that the believers avoided more than did both the nonbelievers ($P = 0.049$) and controls ($P = 0.021$). Nonbelievers and controls did not differ ($P > 0.10$).

Memory or belief? In Experiment 2, did believers simply believe they had gotten sick after eating strawberry ice cream, or did they actually develop a concrete recollection of the experience? Of the elaboration subjects, recall that 24 (41%) met the definition of believers. Of those, 1 (4%) remembered the event and 23 (96%) just believed that it had happened. Of the scenario subjects, recall that 13 (22%) met the definition of believers. Of those, only one (8%) remembered the event and 12 (92%) just believed that it had happened. As in Experiment 1, the vast majority of believers simply believed that the event had occurred.

Recall that after indicating a belief, participants were asked to

Table 2. Mean ratings of items on the Food Preferences Questionnaire (on a 1–8 scale) and the Party Behavior Questionnaire (on a 1–8 scale), split by whether participants believed the relevant feedback (believers), did not believe it (nonbelievers), or were not exposed to it (controls) in Experiment 2

Experimental group	Prefeedback Prefer	Postfeedback Prefer	Prefeedback Party	Postfeedback Party	Overall avoidance
Ice cream elaboration					
Believers (<i>n</i> = 24)	5.46	4.83	5.33	4.88	0.54
Nonbelievers	5.65	5.79	5.44	5.44	−0.07
Ice cream scenarios					
Believers (<i>n</i> = 13)	6.54	5.23	5.62	5.00	0.97
Nonbelievers	5.80	5.56	5.64	5.27	0.31
Controls	5.49	5.69	6.02	5.60	0.11

Overall avoidance calculated as the average difference between pre- and postfeedback on the Food Preferences Questionnaire and Party Behavior Questionnaire; positive avoidance values denote more avoidance. Prefer, Food Preferences Questionnaire; Party, Party Behavior Questionnaire.

“explain why you think the event happened.” After indicating a memory, they were asked to “give as many details as possible about the memory.” To give a flavor of what some participants said, we provide a few verbatim examples:

1. Tummy ache from too much ice cream.
2. May have gotten sick after eating seven cups of ice cream.
3. Probably happened because there wasn’t any other flavor, had to eat strawberry and didn’t like the taste.
4. Definitely got sick from chocolate ice cream; maybe got sick from strawberry ice cream, too.
5. Think it did happen because I liked strawberry ice cream but don’t anymore. I remember I ate lots of Napolean [sic].

Purpose of study. As in Experiment 1, we coded subjects’ open-ended responses on a 0–3 scale (0 = reporting something unrelated to the study’s purpose; 1 = reporting something about memory; 2 = reporting either about false memory or food preference being influenced by childhood; and 3 = mentioning both false memory and its relation to food preference). Of the elaboration subjects, seven received a score of 2, and one received a score of 3. Of the scenario subjects, three received a score of 2 and one received a score of 3. Of the control group, four subjects received a score of 2 and none received a score of 3. These data show that the vast majority (≈90%) of subjects received scores of 0 and 1. Thus, few subjects correctly guessed the study’s purpose. The overall data pattern did not change when we removed these subjects from the analyses.

Recency of eating. We end with one of the questions that motivated this experiment: Are people less resistant to the suggestion that they got sick after eating strawberry ice cream as children by virtue of having recently eaten strawberry ice cream? Contrary to our prediction, the recency of eating strawberry ice cream was unrelated to any of our dependent variables (confidence on the strawberry ice cream item on the Food History Inventory, Food Preferences Questionnaire, Party Behavior Questionnaire). Thus, recently eating strawberry ice cream had little bearing on whether someone would fall for our suggestion that she or he got sick after eating strawberry ice cream as a child, and whether she or he would avoid strawberry ice cream now.

Discussion. Experiment 2 demonstrates that it is possible to lead a substantial minority of people to believe that, as children, they had gotten sick after eating strawberry ice cream. Before our manipulation, they had denied this. After the manipulation, between 22% and 41% came to believe that they had had the experience we suggested to them. More importantly, this new-found autobiographical belief was associated with intent to avoid strawberry ice cream in adulthood. We also showed that among

those who believed the false feedback, most claimed that they believed the event had occurred but did not indicate that they had a concrete recollection of it.

We used two methods of false feedback, one in which subjects elaborated upon the feedback, and the other in which subjects chose the scenario provided that best matched their potential experience with the key food. Both methods significantly increased subjects’ confidence that they had gotten sick after eating strawberry ice cream. Although the elaboration method produced more believers, both methods produced similar levels of avoidance of strawberry ice cream. Finally, contrary to our prediction, the recency with which subjects reported eating strawberry ice cream had no effect on subjects’ confidence that they had gotten sick after eating strawberry ice cream or their avoidance of strawberry ice cream.

General Discussion

We began this work with two simple questions. Can we lead people to believe that, as children, they had a negative experience with a fattening food? Does this false belief lead people to avoid eating the fattening food as adults? Our results show clearly that the answer to both questions is “yes.”

In two experiments, we suggested to some subjects that, as children, they had a negative experience eating strawberry ice cream. In Experiment 1, we also suggested to some other subjects that they had gotten sick after eating a chocolate chip cookie. In both experiments, we used control groups whom we told nothing about these experiences. In both experiments, our false feedback led a substantial minority of subjects to believe that they had felt ill (Experiment 1) or had gotten sick (Experiment 2) after eating strawberry ice cream as children. These false beliefs, in turn, were accompanied by less self-reported willingness to eat strawberry ice cream now. In contrast to this, the false feedback did not work with the chocolate chip cookie subjects in Experiment 1: They did not come to believe that, as children, they had gotten sick after eating a cookie. Our results show that strong false suggestions about some negative food-related childhood experiences can lead people to develop false beliefs and memories about such experiences and to avoid eating those foods as adults.

We do not know precisely why our false feedback worked with strawberry ice cream but not with a chocolate chip cookie in Experiment 1. We speculate that people eat chocolate chip cookies more often than strawberry ice cream and that people will not form false beliefs about frequently consumed foods. Indirect support for this claim comes from the fact that subjects in Experiment 1 reported greater preference and willingness to eat chocolate chip cookies than strawberry ice cream before they received any feedback about these foods.

In Experiment 2, we included a measure of how recently subjects ate various foods, including strawberry ice cream. We hypothesized that people who had eaten strawberry ice cream recently would be less inclined to believe that they got sick after eating strawberry ice cream as children. We found no support for this hypothesis. It is possible that recency and frequency of food-related activities are less related than we had anticipated. It also is possible that our Recent Food Experiences Questionnaire was insensitive to the frequency with which a person eats various foods. Work in our laboratory supports the notion that food novelty may be at least partly responsible for these effects (C.L., E.K.M., D.M.B., and E.F.L., unpublished data). For instance, we have been unsuccessful at making people believe that, as children, they got sick after eating potato chips. Future work should aim to clarify the role of novelty in false food belief and food avoidance.

What leads some people and not others to develop false memories about a particular event? In Experiment 2, we provided two different false feedback exercises to see if we could enhance the false food belief and food avoidance effects that we observed in Experiment 1. We told each subject in the experimental groups that, “as a young child, you got sick after eating strawberry ice cream.” We then asked one group (the elaboration subjects) to elaborate on this event, by imagining what happened (or might have happened). Subjects then answered four questions about this imagined event. We told the other group (the scenario subjects) to choose between one of two possible scenarios that best matched their memory for the event (or what they think might have happened). Both feedback exercises worked as intended by increasing subjects’ confidence that they had gotten sick after eating strawberry ice cream as children.

We believe that our findings have important implications for food choices and dieting. If people can be led to avoid certain fattening foods simply by believing that they had a negative experience with those foods as children, then perhaps people could learn healthier eating habits. Pediatric research has shown that many of the food preferences that one develops in childhood persist into adulthood (15). Our work shows that the mere belief that one had negative experiences with food in childhood may be sufficient to influence one’s adult food preferences.

Public interest in affecting nutritional selection has been particularly strong of late, as public recognition grows about the problem of being obese or even overweight (16, 17). Scientists who worry about this public health crisis know that fixing the problem will require behavioral science interventions to identify the conditions that induce change. Some have even hinted that we might impose laws to help people to eat more healthfully (ref. 18; see ref. 19 for evidence that the health consequences related to obesity are overblown). Although some people might cringe at the thought, keep in mind that seatbelt laws were imposed upon us when people were not using them on their own. Societal attitudes about seatbelt use followed, and many lives were saved, so now many people think that seatbelts are essential.

What Causes False Food Belief and Food Avoidance? Our intention in this work was to determine whether our false-feedback technique would extend to fattening foods. In this way, we did not design the present work to explore the theoretical mechanisms underlying false food beliefs and food avoidance. Identifying potential mechanisms involved in these effects requires further investigation.

Familiarity is one possible mechanism that may play a role in someone coming to believe falsely that she or he had a negative childhood experience with food. According to this idea, imagining that one became ill could increase the familiarity with which that event is processed when it is encountered sometime later. This enhanced familiarity, in turn, could be mistakenly attributed to childhood memory instead of to the false feedback (20, 21). Moreover, this enhanced familiarity could also result in a specific or general dislike of the offending food now.

Another possible explanation for the present results is that our false-feedback technique works by changing associations in memory for the food in question. For example, imagining that one had a negative experience with strawberry ice cream may create a memory trace that “strawberry ice cream is bad.” This association, in turn, could deter one from wanting to eat strawberry ice cream now or in the future. It could be that our false-feedback manipulations condition subjects to avoid strawberry ice cream by creating a conditioned stimulus–unconditioned stimulus pairing, like that observed in many studies of classical conditioning (22).

At a more fundamental level, it might be useful to look for neurophysiological correlates of our findings. Humans and other animals can be conditioned to avoid food. Such conditioned taste aversion leads to many documented changes in the brain, in particular, changes in cholinergic and glutamatergic activity (23). It is unclear whether false food beliefs and their accompanying food avoidance, like those observed here, produce neural reorganization similar to that evident with true memories of bad food experiences (24, 25). Perhaps, at a neural level, the belief that one became sick after eating a certain food as a child is tantamount to actually having the experience.

Finally, our work suggests an intriguing line of inquiry. Unlike other animals, humans can be asked to imagine experiences that they never had. The act of imagination, in turn, can produce false memories that can have behavioral consequences. It would be useful to know whether the consequences of actually having gotten sick after eating a food are similar to the consequences of having a planted false belief about having gotten sick. Thus far, our research suggests that this is indeed the case (13).

Burning Questions. Obviously, many questions remain. We still do not know precisely how long our effects last. For instance, it is possible that the food avoidance that we observed in the present experiments and in our other work dissipates soon after subjects leave the laboratory. If this is true, then our technique for creating false food beliefs and food avoidance will have limited practical utility. Thus, it is important to examine the duration of these false food belief effects.

Another question involves the flip side of false fattening food memories: Can people be led to believe that they had a positive food experience in childhood, and thereby, want to eat more of that food now? Such a result would have obvious practical importance if it provided a way to make people eat more healthful foods. In another study, we tried to make people believe that they loved asparagus the first time they ate it (E.K.M., C.L., D.M.B., and E.F.L., unpublished data). We chose asparagus as our critical item, in part because it is a healthful vegetable but also because it is not a food that most adults would assume that they liked as children. We found that $\approx 40\%$ of our subjects did come to believe this and later indicated wanting to eat asparagus more. Therefore, just like the false negative food beliefs that we observed in the current work, false positive food beliefs can be created, too. These beliefs, in turn, can have behavioral consequences, this time leading to enhanced preference.

Another vital question is whether false food beliefs produce real changes in behavior. Thus far, we have only measured subjects’ self-reported willingness to eat certain foods. A study in which subjects have the actual option of choosing a critical food (e.g., ice cream) among a set of distractor items (e.g., brownies, candy, cake) would address this issue. Will subjects with false food beliefs avoid strawberry ice cream when confronted with an actual dish of strawberry ice cream? We do know that the intention to act is one of the best predictors of true actions (26). Thus, we speculate that our suggestive manipulation will be useful in altering actual eating behavior.

Finally, we still do not know what causes false food belief and food avoidance. It is possible that such effects are due, in part, to demand characteristics (27). That is, subjects might guess the true

nature of the study, and, in turn, try to act in accordance with what they believe they should do in the experiment. Several lines of evidence argue against this concern. First, in Experiment 1, our false-feedback manipulation worked, at least weakly, with strawberry ice cream but not with a chocolate chip cookie. If subjects were responding to demand, then they should have believed the false feedback for both food items. Second, we went to great lengths to disguise the true nature of the study: we embedded the critical item within a large list of distractor items; and we administered multiple distractor questionnaires, including personality measures. Finally, we asked subjects to tell us what they thought the study was actually about. No subjects in Experiment 1 correctly guessed the study's purpose, whereas only 2 of 204 subjects in Experiment 2 guessed the study's purpose. When we omitted from our analyses these correct guessers and those who guessed part of the study's purpose, the results did not change. Furthermore, in other studies, we have shown that demand characteristics are not likely driving the types of effects that we observed here (C.L., E.K.M., D.M.B., and E.F.L., unpublished data). Thus, we think that our findings reflect true distortion of belief, which has repercussions for subsequent thought and behavior.

Appendix

Subject Name: [SUBJECT NAME ENTERED HERE]

After you left the lab last week, we entered your responses to the personality and food history/habits questionnaires into our computer and generated a profile of your early childhood experiences with certain foods. From the data you provided, the computer generated the following profile. As a young child:

1. YOU DISLIKED SPINACH
2. YOU ENJOYED EATING PIZZA
3. YOU GOT SICK AFTER EATING STRAWBERRY ICE CREAM
4. YOU FELT HAPPY WHEN A CLASSMATE BROUGHT SWEETS TO SCHOOL

When you have finished reading the items, please continue to the next page.

[Next Page. Note that experimental subjects received either the Elaboration Exercise or the Lifetime Scenario Database.]

Elaboration Exercise

Consider the following item from your profile:

YOU GOT SICK AFTER EATING STRAWBERRY ICE CREAM

Directions. Think about your memory of this experience. If you don't have a specific memory, imagine what *might have* hap-

pened. Then answer the following questions, in some detail, regarding the item listed above.

1. How old were you?
2. Where did it occur? And what were you doing at the time?
3. Who were you with?
4. How did it make you feel?

Lifetime Scenario Database

For this study, we have access to the Lifetime Scenario Database, a collection of common experiences with food. The Database is based on the findings of a set of food studies conducted by Marcia Wong *et al.* (e.g., Wong, Dymond & Miller, 1998; Wong, Salz, Connor & Roubicek, 2000). Data from hundreds of subjects who have had particular food experiences (e.g., crash diets, alcohol binging, food-related illness, etc.) are analyzed for common elements, and these elements form the basis of a set of scenarios.

Based on the following item from your food profile, we expect that the scenarios below may match your experiences.

YOU GOT SICK AFTER EATING STRAWBERRY ICE CREAM

Directions. Read the two scenarios below. Pick the scenario that best matches your memory of this event, or, if you don't have a specific memory, pick the one closest to what you think might have happened. When you have picked a scenario, check the appropriate box at the bottom of the page.

Scenario 1. I was at a friend's birthday party when I was little. After my friend opened all of the presents, we had strawberry ice cream. The ice cream tasted a little funny, but I ate it anyway. I started feeling really sick and ended up going into the bathroom. I was nauseous and dizzy. I had to leave the party early because I felt so bad. And I was not the only person at the party that got sick.

Scenario 2. I went to a restaurant with my family. The food was really good, so I ate a lot. I was allowed to order dessert. I picked strawberry ice cream. I ate the whole bowl of ice cream, and then I felt really sick to my stomach. Luckily, we left the restaurant soon after. When I got home, I had to lie down, and I felt sick for the rest of the night.

- Scenario 1 best matches my memory
 Scenario 2 best matches my memory

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