

## FALSE MEMORIES ABOUT FOOD CAN LEAD TO FOOD AVOIDANCE

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In two experiments, we suggested to 336 participants that as children they had become ill after eating either hard-boiled eggs or dill pickles. Eighty-three additional control participants in Experiment 1 received no suggestion. In both experiments, participants' confidence increased in line with the suggestion. In the second experiment, we used a pretest/posttest design and found that enhanced confidence was accompanied by avoidance of the relevant food item. These results demonstrate that adults can be led to believe falsely that eating certain foods as children made them sick and that such false beliefs can have consequences.

"Who . . . can cloy the hungry edge of appetite by bare imagination of  
a feast"

(from *The Tragedy of King Richard the Second*, Act I, Scene III).

People often misremember their past. Misleading details can be planted into a person's memory for an event that actually occurred (e.g., Loftus & Palmer, 1974; see Ayers & Reder, 1998, for review). It also is possible to plant entirely false memories, or what we call "rich false memories" (Loftus & Bernstein, 2005). In one of the first studies of rich false memories, participants were led to believe that they had been lost in a shopping mall for an extended period of time before being reunited with their parents (Loftus & Pickrell, 1995). In other work, participants falsely remembered spilling a punch bowl at a wedding

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or going to the hospital late at night for an ear infection (Hyman, Husband, & Billings, 1995). Although some have suggested that such procedures may elicit true memories (Goff & Roediger, 1998), others have shown that the procedure works for highly unlikely events, such as witnessing a demonic possession (Mazzoni, Loftus, & Kirsch, 2001), undergoing an official medical procedure to have skin scraped from one's finger (Mazzoni & Memon, 2003), or riding in a specific hot air balloon (Wade, Garry, Read, & Lindsay, 2002).

These studies demonstrate that it is possible to plant rich false memories. One question that naturally arises from this work is whether rich false memories have long-term effects. Do they affect peoples' attitudes and the behaviors that they might later intend to perform? In her honors thesis conducted in our lab, Collins (2001) investigated whether a false suggestion can have subsequent consequences (reviewed in Pickrell, Bernstein, & Loftus, 2004). She asked participants about their childhood experiences, including whether they had been attacked by a small dog. Later, some of these participants were told falsely that the answers they had previously provided to these questions and others indicated that they had been attacked by a small dog as a young child. When subsequently asked about this key experience, these participants were more confident that the event had occurred in their childhood than control participants who received no false feedback. More importantly, these "believers" reported that they were less likely than the control participants to want to own a small dog as a pet. Although the sample size is small, this work provides some preliminary empirical support for the claim that falsely believing something about one's childhood can influence later attitudes.

To further pursue such effects, we developed a new procedure for exploring the repercussions of a false belief. In the current research, we falsely suggested to participants that, as children, they had become ill after eating certain foods. We then explored whether this suggestion increased their confidence that the event had occurred and whether they were inclined to avoid those foods.

## EXPERIMENT 1

### METHOD

*Participants.* The participants were 237 undergraduates at the University of Washington who received course credit for their time. They were run in small groups.

*Materials and Procedure.* Participants came to a laboratory and were told that they would complete a series of questionnaires. Participants first completed an instrument called the Food Preferences Questionnaire that asked them to rate each of 62 different foods in terms of how much they enjoy the food. Each food (e.g., watermelon, spinach, fish) was rated using a 5-point scale (1 = hate it; 2 = dislike it; 3 = neutral; 4 = like it; 5 = love).

Participants completed a 10-min anagram filler task while the experimenter ostensibly fed the data into a computer for analysis. Participants then were given false feedback about their data. They were told falsely that we had entered their responses into the computer and generated a profile of their early childhood food experiences, referring back to age three or four. The seemingly individualized profiles told them that they had gotten sick eating a particular food. A portion of the profile was identical for all: when they were 3 or 4 years-old, they disliked spinach and enjoyed fried foods and chocolate-covered almonds. These items were included to lend credibility to the profile, in that we assumed that most people would have had these experiences.

The critical item was embedded in the third position of the profile. Approximately one-third of the participants ( $n = 77$ ) were told that they had gotten sick after eating hard-boiled eggs (Egg Feedback), another third ( $n = 77$ ) were told that they had become sick from eating dill pickles (Pickle Feedback), and the remainder ( $n = 83$ ) received a three-item profile that mentioned spinach, fried foods, and almonds but nothing about eggs or pickles (Controls). To ensure that they processed the feedback, we told participants that the computer had randomly selected two of the items for them to elaborate upon: the first was the chocolate-covered almonds and the second was the critical item (pickle or egg, respectively). During this phase, participants were asked to answer two questions about each item. For the critical item, they were asked: "Try to imagine where you were when you got sick from eating [dill pickles]. Were you: a) at home; b) on a picnic; c) at a birthday party; or d) other \_\_\_\_\_" and "Imagine what the [dill pickles] tasted like. Was the taste: a) bitter; b) salty; c) sour; or d) other \_\_\_\_\_?" Participants in the control condition imagined eating the almonds only and answered two questions about this item.

The false feedback materials were collected and new materials were distributed. To see if the false feedback influenced participants'

confidence that the critical event happened in their past, they completed a 24-item questionnaire that asked about childhood experiences involving various foods. The questionnaire was modeled after the life-events inventory that has been used in other studies (Garry et al., 1996); thus, we refer to it as a Food History Inventory (FHI). The FHI asks about experiences that may have happened before age 10. Participants respond on an 8-point scale, with a response of 1 indicating that the event definitely did not happen before the age of 10 and a response of 8 indicating that the event definitely did happen before the age of 10. Embedded within this questionnaire were two critical items: "Felt ill after eating a dill pickle" and "Got sick after eating too many hard-boiled eggs," which were in positions 9 and 16, respectively. The FHI is printed in the Appendix.

Finally, to see if the false feedback influenced subsequent behavior, participants completed a questionnaire involving an imaginary party with various beverages and foods available (hereafter, the "Party Behavior" questionnaire). They were told to "imagine that you are at an afternoon barbecue party with 100 guests." Then they indicated their likelihood of consuming each of 37 options (e.g., peanut butter sandwiches, stuffed mushrooms, diet cola). These options were presented in sections. For example, the first section read: "Shortly after you arrive, you find a bucket full of bottled drinks. How likely are you to pick each of the drink choices below?" Participants indicated the likelihood of selecting each of: (a) seven different drinks (e.g., cola, tonic, water); (b) six different types of finger sandwiches (e.g., turkey, avocado); (c) eight different appetizers (potato chips, carrots with ranch dip); (d) 10 different hamburger toppings (e.g., mustard, tomatoes); and (e) six different ice cream flavors (e.g., strawberry, rocky road). They rated each item on an 8-point scale anchored by "definitely no" on the low end (1), "maybe" at mid-scale (4 and 5), and "definitely yes" at the high end (8). The two critical items, dill pickle spears and salted hard-boiled eggs, were in the third section. This section read: "After a bit of a swim in the host's pool, you see another table with snacks. How likely are you to pick each of the nibblers below?" The critical items were in the fourth and eighth positions of this section. The reason for using such a large set of filler items was to attempt to mask the obviousness of the critical items. After this questionnaire, participants were debriefed and thanked.

## RESULTS

Did the false feedback about an adverse childhood food experience (pickle or egg) affect participants' responses? Consider first the three bars on the left side of Figure 1. Participants who were told falsely that they had gotten sick from eating dill pickles (Pickle Feedback) were more confident that as a child they "felt ill after eating a dill pickle" than those who were not given false feedback about eating pickles. The mean rating for the Pickle Feedback group on the pickle item on the FHI was 2.94, compared to 2.36 for the Egg Feedback group, and 2.47 for Controls. To see whether the pickle feedback led to more avoidance of the pickle item, consider the third set of bars in Figure 1. Pickle Feedback participants indicated less desire to eat dill pickle spears at an imaginary barbecue. Their mean rating was 3.42, while the corresponding ratings for the Egg Feedback group and Controls were both 3.82. Thus, numerically speaking, participants showed increased confidence that they felt ill after eating a dill pickle and had reduced interest in eating a pickle. But, as will become evident, only the increased confidence was statistically significant.

In one inferential test, we compared the Pickle Feedback group's mean rating for the item assessing confidence that they had gotten ill after eating a dill pickle to the mean rating on that item for the Egg Feedback group and Control group combined. This resulted in a significant difference,  $t(233) = 1.95, p < .05$ , one-tailed (statistical tests presented in this article are 2-tailed unless otherwise specified, as in the present case). In a second inferential test, we compared the Egg Feedback group's mean rating for the item assessing confidence that they had gotten ill after eating hard-boiled eggs to the mean rating on that item for the Pickle Feedback group and Control group combined. This difference was not significant,  $t(234) < 1.0$ . Thus, the false dill pickle feedback significantly increased participants' confidence that they had become ill after eating a dill pickle as children. The false hard-boiled egg feedback had little effect on confidence.

Next, we tested whether the false pickle and egg feedback led to avoidance of pickles and eggs, respectively, on the Party Behavior questionnaire. To determine this, we compared the Pickle Feedback group's mean rating for the item assessing the likelihood of eating pickles at the party to the mean rating for that item of the Egg Feedback group and Control group combined. Although the Pickle Feedback group indicated that they would be less likely to eat the pickle

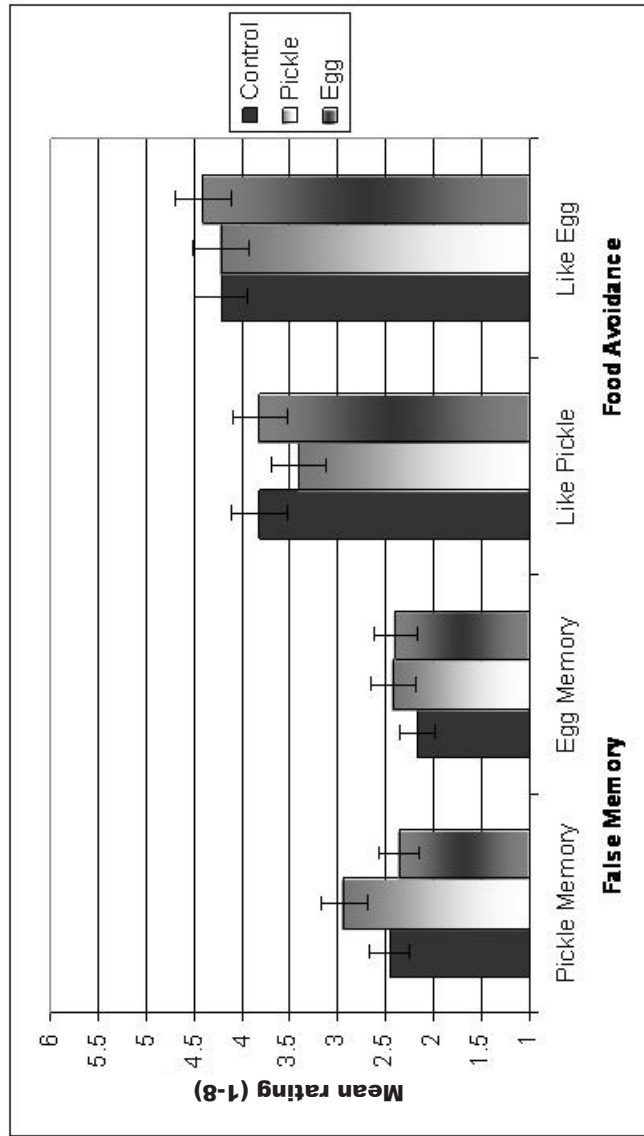


FIGURE 1. Mean False Memory (from Food History Inventory) and Food Avoidance (from Party Behavior questionnaire) ratings for Experiment 1. Pickle – False Memory = mean confidence that participant felt ill after eating a dill pickle before the age of 10. Egg – False Memory = mean confidence that participant got sick after eating too many hard-boiled eggs before the age of 10. Pickle – Food Avoidance = mean rating that participant would choose to eat dill pickles at an imaginary barbecue. Egg – Food Avoidance = mean rating that participant would choose to eat hard-boiled eggs at an imaginary barbecue. Note that higher scores on the two Food History items indicate greater confidence in the childhood memory. Higher scores on the two Party Behavior items indicate greater willingness to eat the item. Error bars are Standard Error of the Mean.

item at the imaginary barbecue than did those who did not get false pickle feedback, the difference was not significant,  $t(234) = 1.14, p > .1$ . A similar analysis that compared avoidance of those who received false egg feedback to those who did not also revealed no significant difference. Put another way, those given the egg feedback were not less likely to claim that they would eat hard-boiled eggs at a party,  $t(233) < 1.0$ .

## DISCUSSION

These results indicate that false feedback about becoming sick after eating dill pickles can increase people's beliefs that the experience occurred. However, this false belief did not appear to lead people to avoid dill pickles as adults. While the avoidance scores were lower than the combined control scores, the reduction was not statistically significant.

One problem with the current posttest design is that we cannot know which participants did and which did not accept the false feedback. Our Party Behavior scores presumably include both those who believed the feedback (believers) and those who rejected it (non-believers). It could be the case that the believers were showing avoidance and the non-believers were masking this effect. To remedy this problem, we modified our paradigm and used a pretest/posttest design in Experiment 2. This permitted us to identify groups of believers and non-believers and to trace avoidance behavior separately for the two groups. To accomplish this, we ran a two-session experiment in which participants received an FHI twice, once before and once after receiving false feedback. This permitted us to identify those individuals who showed increased confidence in the critical childhood experience and to compare them to those who did not.

## EXPERIMENT 2

### METHOD

*Participants.* The participants were 180 undergraduates at the University of California, Irvine, who received course credit for their time. They were run in small groups.

*Materials and Procedure.* On their arrival at the lab (at Time 1) participants completed the FHI, which was identical to the one used in Experiment 1. To disguise the true nature of the experiment, partici-



pants also completed three filler questionnaires involving personality and eating habits.

One week later (at Time 2), participants returned and were given false feedback about their earlier data. They were told falsely that we had entered their responses into the computer and generated a profile of their early childhood experiences with certain foods. Again, the profiles were presented as if they had been individually tailored to the specific participant. A portion of the profile was identical for all: as a young child, “you disliked spinach,” “you enjoyed fried foods,” and “eating chocolate birthday cake made you happy.” The critical item was embedded in the third position of the profile. Approximately half of the participants ( $n = 91$ ) were told that they got sick after eating a hard-boiled egg (Egg Feedback) and the remaining participants ( $n = 89$ ) were told that they got sick after eating a dill pickle (Pickle Feedback). Unlike in Experiment 1, there was no pure control group. Thus, for each participant, there was a critical manipulated item and a critical non-manipulated item (e.g., for the Egg Feedback group, the critical manipulated item was a hard-boiled egg and the critical non-manipulated item was a dill pickle). To ensure that participants processed the feedback, all participants answered questions about the chocolate cake item and their critical item. For the critical item, they were asked: “To what extent do you feel that this event is reflected in your personality today?” They responded by circling a number between 1 – *not at all* and 8 – *very much*. The second question was: “How is your personality different because of this event? (For example, are you more timid? More sociable? Happier?)” Blank lines provided space for an open-ended response.

Next, participants completed the FHI again. This second set of responses was used to determine whether there were changes in their confidence that the critical event had happened in their childhood. In addition, they completed two questionnaires designed to explore their avoidance of the critical foods. The Party Behavior questionnaire measured the likelihood of the participants consuming each of 37 options at an afternoon barbecue. It was identical to the one used in Experiment 1.

As a dependent measure, we used a Food Preferences questionnaire that measured how much participants like eating various foods in general. (A version of this questionnaire was used in Experiment 1, not as a dependent measure, but as a preliminary measure de-



signed to give credibility to the false feedback.) In Experiment 2, the Food Preferences questionnaire presented 64 items and asked participants to rate each in terms of how much they enjoy it, using a scale of 1 – *definitely don't like to eat (for whatever reason)* to 8 – *definitely like to eat*. Two critical items, dill pickle spears and hard-boiled eggs, were embedded in the list.

Finally, participants completed a questionnaire entitled “Memory or Belief?” This questionnaire asked for a few more details about their food history. It listed three food experiences (all from the FHI) that might have occurred and asked subjects to indicate whether they had a specific memory of the event from before age 10. The three items included the relevant critical item plus two distracter items. Participants wrote M to indicate they had a specific memory for the event and gave “as many details as possible.” They wrote B if they believed the event happened but had no specific memory of it, and they explained why they believed the event happened. They wrote P if they were positive that the event did not happen and explained how they were so sure that the event did not happen.

## RESULTS

*False Food Memory.* Did false feedback about the occurrence of a food-related event affect confidence that the event happened in childhood? The data showing mean changes in participants' perceived likelihood that such events occurred are shown in Figure 2.

Consider the left side of the figure. Participants who were told falsely that they had gotten sick from a dill pickle (Pickle Feedback) showed that false feedback suggesting that they had gotten sick after eating a dill pickle affected the perceived likelihood that the event had occurred (pre-feedback  $M = 2.25$ , post-feedback  $M = 3.13$ ). Participants who were told that they had gotten sick from a hard-boiled egg (Egg Feedback) showed virtually no increase in their rating of the likelihood that they had gotten sick after eating a pickle ( $M_s = 2.04$  and  $2.11$ ). A similar pattern occurs on the right side of Figure 2. The Egg Feedback group increased its rating of the egg item from 2.29 at Time 1 to 2.92 at Time 2, while the Pickle Feedback group's rating increased minimally from 2.31 to 2.48.

Prior to conducting inferential tests, we calculated for each participant and for each of the two critical items the difference between responses on the FHI at Time 1 and Time 2. We then averaged these differences for the two groups, to give us four separate means: Time 1

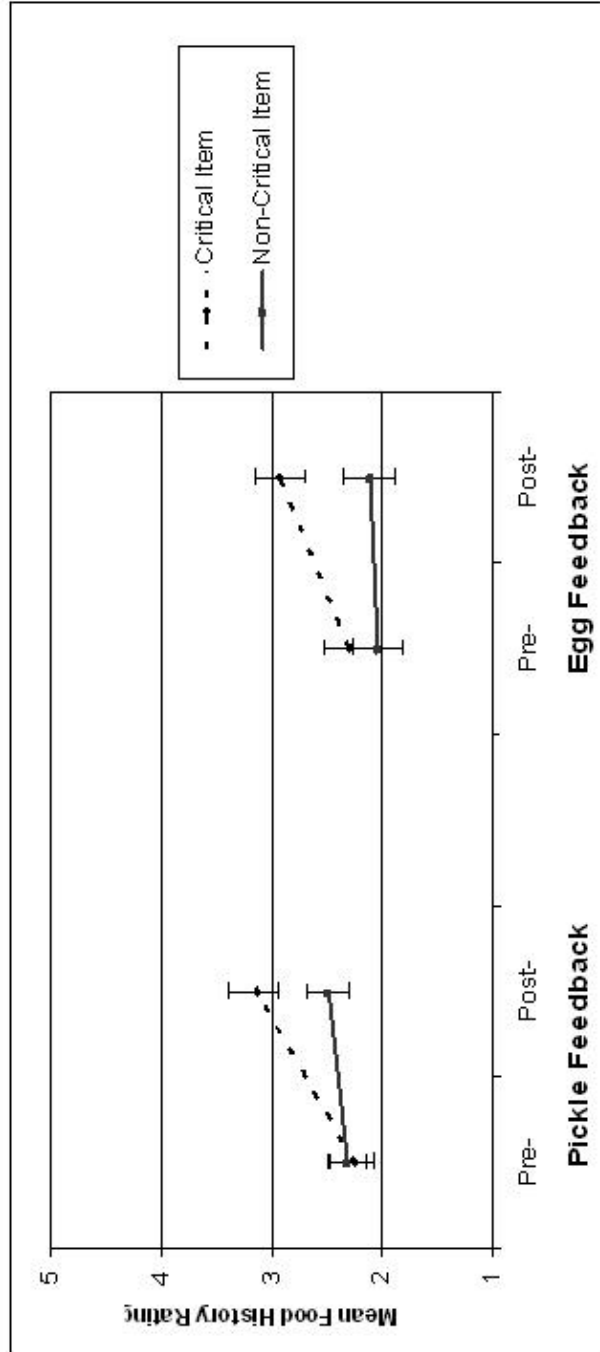


FIGURE 2. Ratings of pickle and egg items on Food History Inventory before (pre-) and after (post-) the pickle and egg false feedback in Experiment 2. Higher scores on the Food History Inventory indicate greater confidence in the childhood memory. Error bars are Standard Error of the Mean.

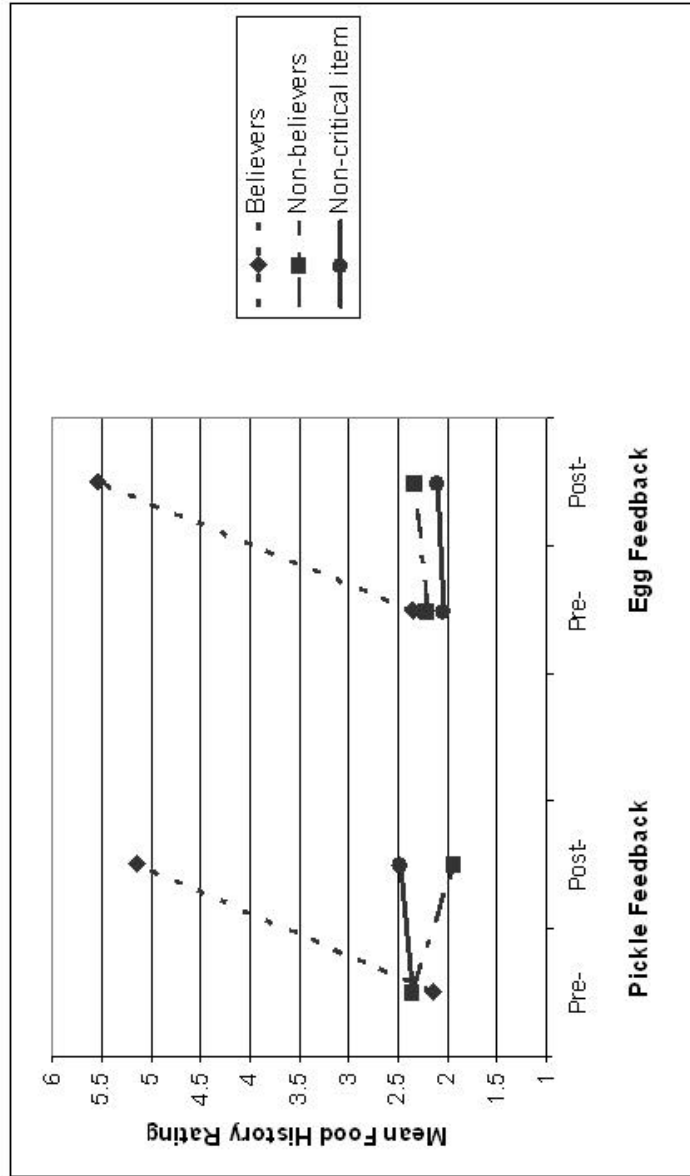


FIGURE 3. Ratings of critical items on Food History Inventory before (pre-) and after (post-) the pickle and egg false feedback in Experiment 2, split according to whether participants “believed” the false feedback. Note: “Non-critical item” represents the mean of all participants in the other experimental group, i.e., for the left portion of the graph, the “non-critical item” refers to the mean of all Egg Feedback group participants, regardless of whether they were Egg “believers.” Higher scores on the Food History Inventory indicate greater confidence in the childhood memory.

and Time 2 means for both the pickle and egg items. We subjected these values to a 2 (Food Type: Pickle, Egg)  $\times$  2 (Target of Feedback: Yes, No) ANOVA, which yielded a significant effect of Target of Feedback,  $F(1,179) = 13.22, p < .001$ , and no other effects ( $F_s < 1.0$ ). To more easily appreciate this effect, we examined the effect of feedback on the two items separately. The pickle feedback significantly increased the ratings of the pickle item,  $t(88) = 3.76, p < .001$ , but it did not increase the ratings of the egg item,  $t(88) < 1.0$ . Conversely, the egg feedback significantly increased the egg item ratings,  $t(90) = 2.92, p < .01$ , but did not increase the ratings of the pickle item,  $t(90) < 1.0$ .

Among those who “believed” the feedback, how much did their confidence change? First we needed to decide what criteria to use to classify someone as a “believer” in the feedback. We could have chosen to use a liberal or conservative criterion. If we had used a liberal criterion, we might arbitrarily define believers as those who became more confident that they had gotten sick. By this criterion, we would classify 35 Pickle Feedback participants (39%) as believers. These participants’ confidence increased 2.94 points, on average. Also, we would classify 33 Egg Feedback participants (36%) as believers. On average, these participants’ confidence increased 2.76 points. One problem with this liberal definition is that some of these supposed believers later told us that they were positive the event did not happen. Thus, we chose to define believers more conservatively, specifically as those who became more confident that they had gotten sick and also later reported that they either remembered or believed the event on the Memory–Belief Questionnaire. In other words, we eliminated participants who later said that the event did not happen. By this more conservative definition, the 22 Pickle believers (25%) showed an average increase of 3.18 points in their ratings and the 28 Egg believers (31%) showed an average increase of 3.0 points in their ratings. These large increases can be seen in Figure 3, where they are contrasted to the lack of an increase among the non-believers.

*Food Avoidance.* Next, we asked whether the false feedback led participants to avoid pickles and eggs. One answer can be found in the analysis of the Party Behavior questionnaire, which included one critical item assessing pickle avoidance (dill pickle spears) and one critical item assessing egg avoidance (salted hard-boiled eggs). The mean ratings for the pickle avoidance item were numerically lower for those who had received pickle feedback than for those who had not (3.16 versus 3.45). In addition, the mean ratings for the egg avoid-

ance item were lower for participants who had received egg feedback than for those who had not (3.84 versus 4.26). We conducted a  $2 \times 2$  ANOVA on these data. There was a main effect of the food type (greater inclination to eat eggs than pickles),  $F(1, 177) = 11.45, p < .001$ . There was no main effect of the target of feedback,  $F < 1$ . There was, however a trend toward an interaction,  $F(1, 177) = 2.67, p < .06$ , one-tailed. The interaction trend can be understood in this way: when given pickle feedback, participants strongly prefer egg over pickle, as shown by a within-subjects t-test,  $t(87) = 3.5, p < .001$ ; however, when given egg feedback, participants no longer prefer egg over pickle,  $t(90) = 1.25, p = .21$ .

One problem with the above analysis is that believers and the non-believers who outnumber them are lumped together. The believers could have shown strong avoidance that is masked by lumping them with their more numerous non-believing counterparts. So, we reanalyzed the Party Behavior items, comparing three groups of participants: those who believed in the feedback, those who did not believe it, and those who were never exposed to it (i.e., those participants in the opposite feedback group). These data are shown in Table 1. Notice that believers gave lower ratings to the critical items. For the pickle item, the only significant difference was between the believers and the non-exposed,  $t(111) = 1.98, p < .05$ , one-tailed. For the egg item, the only marginally significant difference was between the believers and the non-exposed,  $t(114) = 1.57, p < .06$ , one-tailed. Thus, the false food feedback affected people's intention to eat the critical, manipulated food, but only if they believed the feedback.

*Ripple Effects?* The Party Behavior questionnaire contained non-critical items that were related to pickles and eggs. These items were pickle slices (offered as a hamburger topping) and egg salad (offered as a finger sandwich choice). Would believing false feedback also lead to a ripple effect—to avoidance of these closely related “ripple” items? These data too are shown in Table 1. As with critical items, believers gave lower ratings to the ripple items. For pickle slices, believers were marginally significantly different from the non-exposed,  $t(111) = 1.88, p < .07$ . For egg salad, believers were significantly different from the non-exposed,  $t(115) = 2.29, p < .05$ . Thus, the false food feedback sometimes affected people's intention to eat related foods.

One issue that arises is whether believers were more prone to food avoidance in general or whether they only avoided the foods men-

TABLE 1. Mean ratings of items on the Party Behavior Questionnaire (on scales of 1–8) for critical and ripple items, split by whether participants believed the relevant feedback, did not believe it, or were not exposed to it in Experiment 2.

Food Item	Type of Participant		
	Believers	Non-believers	Non-exposed
Critical items			
Dill pickle spears	2.36	3.46	3.45
Salted hard-boiled egg	3.43	4.02	4.26
Ripple items			
Pickle slices	3.50	4.85	4.78
Egg salad (finger sandwich)	3.43	4.49	4.64
Mean across all items	3.18	4.21	4.28

tioned in the false feedback. Would egg-believers be less likely to want to eat potato chips or stuffed mushrooms, as well as salted hard-boiled eggs? To explore this question, we examined Party Behavior for all of the filler items. We found that believers did not avoid the filler foods more than non-believers. The mean intention to eat the filler items was 4.89 for the 22 Pickle believers (versus 4.87 for the 67 non-believers). The mean intention to eat the filler items was 5.12 for the 28 Egg believers (versus 4.87 for the 63 non-believers). Thus, it was not the case that the believers avoided all foods.

Recall that participants also filled out a questionnaire regarding their general food preferences. In the interest of space, these data will not be presented. Suffice to say they showed very similar results, and thus would be duplicative.

*Memory or Belief?* Finally, we asked whether believers remembered getting sick from the critical item or if they just believed that the event happened. Of the 22 Pickle believers, four (18%) remembered the event and 18 (82%) just believed that it had happened. Of the 28 Egg believers, 5 (18%) remembered the event and 23 (82%) just believed that it had happened.

Recall that after indicating a Belief, participants were asked to “explain why you think the event happened,” and 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. Sample Belief Response: "I did not like to eat boiled eggs for years. It has to be something." This person moved on the FHI from 1 to 6 on the egg item.

2. Sample Memory Response: "One Easter, my Mom, brother, and I boiled eggs to dye later. My Mom said to take only the ones we were going to use. Of course, we boiled too many, got bored of dyeing eggs, and my mom forced us to eat the remaining (~3 each) to teach us a lesson, 'Don't waste food.'" This person moved on the FHI from 1 to 6 on the egg item.

3. Sample Memory Response: "I had a cheese quesadilla with lots of pickles. I got sick afterwards and I through (sic) up the food, and all I tasted and smelled [after throwing up] was the pickles." This person moved on the FHI from 1 to 8 on the pickle item.

These examples show that the final reports can often be quite detailed. Although we cannot verify that these events never happened, these individuals initially strongly denied the experience and later embraced it. We address the issue of authenticity in the general discussion.

#### A CASE HISTORY OF A BELIEVER

To put a human face on what a "believer" looks like in this study, we present the example of a 20-year-old female (whom we call Sue) who received false pickle feedback. Recall that to ensure that participants processed the false feedback, we required them to answer questions about the extent to which the getting-sick event was reflected in their personality and how their personality might be different today because of this event. While many wrote very little (e.g., "more sociable" or "more stubborn"), some were more elaborate and their elaborations may be a clue as to how the false feedback might work. Sue was one such participant. Responding to the false feedback questions, she wrote, "It might have made me a little like a worry wart about things, especially the foods I eat. I'm a little more careful." She moved from a 3 to a 5 on the FHI. In terms of Party Behavior, she gave "dill pickle spears" a rating of "2." On the Memory-Belief questionnaire, she gave the key item a "B" response, writing: "It is very likely that this did happen. I remember this roller-skating rink we used to go to & they would sell really big pickles. Sometimes my mom would [buy] them for us and I could have gone to skate and felt sick." As this



example illustrates, individuals will sometimes recruit a fair amount of presumably autobiographical detail to embellish their beliefs.

## DISCUSSION

Experiment 2 demonstrates that it is possible to convince a substantial minority of people that, as children, they had gotten sick either after eating hard-boiled eggs or after eating a dill pickle. More importantly, this false autobiographical belief was associated with intent to avoid such foods in adulthood. The participants who believed in the false feedback not only showed avoidance of the critical food item (e.g., salted hard-boiled eggs), but also showed avoidance of a closely related item (e.g., egg salad). We also showed that among those who believed the false feedback, the large majority claimed that they believed the event occurred but did not indicate that they had a concrete recollection of it. A number of individuals provided rather detailed and specific recollections of events that they had previously denied experiencing.

## GENERAL DISCUSSION

To reiterate our major findings, we suggested to participants that they became ill as children after eating too many hard-boiled eggs or after eating a dill pickle, and the suggestion increased their confidence that this had happened. The post-test design of Experiment 1 provided only suggestive evidence that this increased confidence was accompanied by a decrease in participants' willingness to eat those foods now. However, the pre-test/post-test design of Experiment 2 furnished more direct evidence that a false suggestion of a negative childhood food experience can lead to avoidance of that food in adulthood. This design also permitted us to pinpoint individuals who accepted the false feedback. It was these participants who were most likely to avoid the critical food items on the Party Behavior questionnaire. The participants who believed in the false feedback not only showed avoidance of the critical food item (e.g., dill pickle spears), but also showed avoidance of a closely related item (e.g., pickle slices).

Why does the false feedback manipulation increase confidence that the event occurred? And, when it is successful, why does it lead to avoidance of the critical food? We believe that both being pro-

vided with the false feedback and being encouraged to process/think about it may be critical to our results. The false feedback was presented as coming from a sophisticated computer analysis of the participant's personal data, lending an air of authority and enhancing its plausibility. After being told that the analysis was probably true, the participant was encouraged to think about the getting-sick experience. Perhaps this instruction encouraged some participants to imagine how the event might have happened or how it might be affecting them as an adult.

Recent work has shown that imagination can have powerful effects on a variety of behaviors. The entire manipulation may have served to increase the familiarity of the critical event, so that when queried later about whether they "got sick after eating too many hard-boiled eggs" before age 10, the item seemed more familiar to the participants. The participant may have mistakenly attributed that familiarity to childhood experience rather than to the recent manipulation (Bernstein, Godfrey, Davison, & Loftus, 2004; Bernstein, Whittlesea, & Loftus, 2002). Some individuals simply have assumed that the event happened; after all, a seemingly authoritative source had suggested it. They may try to recruit related experiences to bolster this belief, such as: "I did not like to eat boiled eggs for years. It has to be something." Other individuals actually may begin to imagine the experience or even recruit some memory details that may have happened to someone else. The imagination may imbue the belief with sensory detail, producing a rather detailed report, such as: "I got sick from eating 'a cheese quesadilla with lots of pickles.' "

As we mentioned earlier, we cannot prove the falseness of the reports we received. One could certainly argue that the manipulation triggered a true belief rather than planting a false one. Even if participants initially denied the experience, we have no way of knowing that it did not occur. Moreover, while we think it is rather unlikely that such a large percentage of participants would have gotten sick as children on the two particular items that we arbitrarily chose to use in this research, we cannot prove that it did not happen. One additional finding that seems inconsistent with the idea that we triggered true memories and brought them into the participants' consciousness is that, at the end of the study, most of our believers indicated that they had just a belief that the event happened rather than a full-fledged sensory recollection. In any event, if one does not want to refer to these as false memories, they are certainly recently

“flipped” memories. That is, the individuals initially denied the experience and later embraced it.

#### RELATION TO FOOD AVERSION AND SOCIAL PSYCHOLOGICAL RESEARCH

Food aversion studies indicate that even a single bad experience with a food can cause animals to avoid that food (Garcia & Koelling, 1966; Garcia, Kimeldorf, & Koelling, 1955). Moreover, research shows that rats can learn to avoid food, even when they are not directly sickened by it (Holland, 1981). Our research adds to this latter finding by showing that humans can be trained to avoid food by merely receiving the false suggestion of sickness.

Our findings also relate to work in social psychology, most notably that on attitude–behavior consistency (Fazio & Zanna, 1978), persuasion (Zimbardo, Weisenberg, Firestone, & Levy, 1965), cognitive dissonance (Brehm, 1959), and the sleeper effect (Kelman & Hovland, 1953). Fazio and colleagues have shown that the more accessible and available attitudes are in memory, and the more confident one is about those attitudes, the more consistency there is between attitudes and behavior (Fazio & Zanna, 1978; Fazio, Powell, & Williams, 1989).

In work involving persuasion and cognitive dissonance, Brehm (1959) and Zimbardo and colleagues (1965) have shown that people can be induced to eat certain foods that they otherwise would not eat (e.g., vegetables or fried grasshoppers). In these studies, participants’ attitudes toward various foods were assessed at one point. Some time later, participants were asked to eat an offending food. To increase cognitive dissonance, Brehm told some participants (eighth graders) that a letter would be sent to their parents explaining that the children had eaten a vegetable (e.g., broccoli, Brussels sprouts) at school. This letter was intended to scare the children into believing that they would, consequently, have to eat more of the vegetable at home. In Zimbardo et al.’s study, the experimenter was either unpleasant (high dissonance) or pleasant. In both experiments, participants increased their liking of the food more in the high dissonance condition. Thus, participants do not like the food at the outset, yet they end up eating the food to receive a reward (e.g., money or movie tickets). When they dislike the experimenter or are worried that their parents will find out that they ate this food, they find it difficult to

justify the fact that they have eaten the undesired food (cognitive dissonance). They move to reduce this dissonance by increasing their liking of the food. In other words, they change their attitudes toward the undesirable behavior. As Brehm notes, “the greater is the discrepancy between attitude and behavior, the greater will be the subsequent pressure to change the attitude” (p. 382). In the present work, rather than increasing participants’ liking of certain foods (as was done in the Brehm and Zimbardo et al. studies), we managed to decrease their liking of the foods. Future work might explore the role of cognitive dissonance in false memory and food avoidance, as well as the persistence of attitude change after participants leave the study (although see Greenwald, 1975, for limitations of cognitive dissonance as a theoretical construct).

Finally, our work may relate to the sleeper effect, where participants are told to discount information they learned previously because it has come from an unreliable source (e.g., Pratkanis, Greenwald, Leippe, & Baumgardner, 1988). In such work, people tend to forget the source, but remember the content of the information. Thus, over time, they come to believe in the truth of the information. The present methodology of suggesting to participants that they became ill after eating certain foods in the past may be a type of sleeper effect; however, it is unlikely that participants have forgotten the source of the false feedback by the time they complete the FHI a second time and the consequence measures. The sleeper effect would explain why, over time, the suggested information might come to be believed. By this account, participants forget the source of the information but remember the content—that they became ill. Future work might investigate whether the sleeper effect would explain how people form enduring false memories. More broadly, source dissociation techniques, such as that used to study the sleeper effect, provide a valuable approach to studying memory distortion (Betz, Skowronski, & Ostrom, 1996).

#### LIMITATIONS

We acknowledge a limitation of the current study. Specifically, it is possible that some of our results reflect demand characteristics. We administered the dependent measures soon after providing false feedback to participants. Perhaps some participants realized

the relationship between the feedback (e.g., “you became ill after eating a dill pickle”) and the subsequent Party Behavior questionnaire (e.g., “how likely are you to eat... dill pickle spears...?”). We took several precautions to try to minimize demand characteristics in the present studies. We embedded the critical false feedback item in a list of other distracter items in the feedback profile. We also asked participants to think about the critical item and one other distracter item in the feedback profile to prevent the critical item from standing out. We embedded the critical food items in a long list of other items on the FHI. In Experiment 2, we gave numerous instruments that concerned “personality” to try to persuade the participants that the study was about personality rather than about false food memories. Finally, during the debriefing, we asked participants what they thought the study was about. Virtually no one gave an answer that indicated any realization of the research hypotheses.

Despite these caveats, there are other ways that the study could be done to minimize the possibility of demand characteristics. One way would be to disguise the initial questionnaires and subsequent feedback profiles as separate studies. This has been done successfully in other research that revealed strong effects of false feedback on confidence in implausible childhood experiences (Loftus & Mazzoni, 1998; Mazzoni & Loftus, 1998). Another way to minimize the demand characteristics would be to increase the time interval between the false feedback and the subsequent tests for its influence. For example, participants could receive the false feedback and then return several days or weeks later to complete the remaining questionnaires. In other studies where the interval is longer, strong effects of suggestive techniques have been observed (Manning, 2000, summarized in Loftus, 2001).

## CONCLUSION

In sum, people can be led to believe falsely that they had negative childhood experiences with certain foods. Moreover, this false belief leads to avoidance of the foods in adulthood. Future work might explore the generalizability of these findings to other foods, perhaps even junk foods. If people who receive a suggestion that they got sick eating chocolate cake later avoid cake, such a finding could have tremendous dieting implications. It also would be desirable to show

that when confronted with the actual foods (instead of an imaginary barbecue), people truly would avoid eating these foods. We are optimistic that these findings would be observed in a study using actual foods because a primary determinant of a person's behavior is the intention the person has to perform that behavior (Cappella, Yzer, & Fishbein, 2003).

A look at the real world provides numerous instances where false beliefs can affect what people think and do. People who were led to believe that they were molested in satanic cults by their parents have later filed charges or lawsuits against the parents (Lof-tus & Ketcham, 1994). A particularly tragic illustration of how changing beliefs or memories can influence what people think or do later in life is provided by the behavior of the Heaven's Gate cult, a group whose members were led to believe that they were in telepathic contact with aliens (Bensley, 2003). Apparently, the cult members had taken out an insurance policy to insure themselves against being abducted, impregnated, or killed by aliens. The group paid \$1,000 a year for this coverage. Clearly their (presumably false) beliefs had significant economic consequences (Siepel, 1997). Thirty-nine members of the cult participated in the ultimate act of consequence: they partook in a mass suicide in 1997, killing themselves under the belief that to do so would free their souls.

We, of course, planted more benign beliefs—that one got sick eating a particular food. We have shown that some people will later avoid those foods.

So, as Shakespeare knew well, imagining a feast would not be likely to cloy the hungry edge of appetite. However, our results suggest that imagining getting sick on the feast might do the trick.

## APPENDIX: FOOD HISTORY INVENTORY (FHI)

Below is a list of events that may or may not have happened to you before you were 10 years old. Please read each event and rate on an 8–point scale how certain you are that the event (or a very similar event) did or did not happen to you by circling one of the numbers to the right of the item. Circle the “1” only if you are *completely confident* that the event **did not** happen to you before you were 10 years old. Circle the “8” if you are *completely confident* that the event **did** happen to you before you were 10 years old. And, if you are not completely confident, choose one of the middle numbers.

	Definitely did not happen				Definitely did happen			
	1	2	3	4	5	6	7	8
1. Ate two scoops of ice cream on a cone	1	2	3	4	5	6	7	8
2. Sold chocolate bars for a school fundraiser	1	2	3	4	5	6	7	8
3. Broke a piñata at a birthday party	1	2	3	4	5	6	7	8
4. Felt uncomfortably full after eating Thanksgiving dinner	1	2	3	4	5	6	7	8
5. Ate too much ice cream	1	2	3	4	5	6	7	8
6. Helped someone peel potatoes	1	2	3	4	5	6	7	8
7. Baked a birthday cake	1	2	3	4	5	6	7	8
8. Ate dinner at a very fancy restaurant	1	2	3	4	5	6	7	8
9. Felt ill after eating a dill pickle	1	2	3	4	5	6	7	8
10. Spilled a bowl of punch at a wedding	1	2	3	4	5	6	7	8
11. Slipped on a banana peel and fell down	1	2	3	4	5	6	7	8
12. Made kool-aid by yourself	1	2	3	4	5	6	7	8
13. Bought school lunch	1	2	3	4	5	6	7	8
14. Ate a hotdog with onions and sauerkraut	1	2	3	4	5	6	7	8
15. Ate a candy apple at a state fair	1	2	3	4	5	6	7	8
16. Got sick after eating too many hard-boiled eggs	1	2	3	4	5	6	7	8
17. Had a cheese pizza delivered	1	2	3	4	5	6	7	8
18. Ate freshly picked vegetables	1	2	3	4	5	6	7	8
19. Baked a pie with your mother	1	2	3	4	5	6	7	8
20. Were forced to go on a diet	1	2	3	4	5	6	7	8
21. Ate a caramel apple at a fair	1	2	3	4	5	6	7	8
22. Felt sick after eating airline food	1	2	3	4	5	6	7	8
23. Had a corn dog at a baseball game	1	2	3	4	5	6	7	8
24. Ate breakfast in bed with your parents	1	2	3	4	5	6	7	8



## REFERENCES

- Ayers, M. S., & Reder, L. M. (1998). A theoretical review of the misinformation effect: Predictions from an activation-based memory model. *Psychonomic Bulletin & Review*, *5*, 1–21.
- Bensley, D. A. (2003). Can minds leave bodies? A cognitive science perspective. *Skeptical Inquirer*, *27*, 34–39.
- Bernstein, D.M., Godfrey, R., Davison, A., & Loftus, E.F. (2004). Conditions affecting the revelation effect for autobiographical memory. *Memory & Cognition*. Manuscript in press.
- Bernstein, D. M., Whittlesea, B.W.A., & Loftus, E. F. (2002). Increasing confidence in remote autobiographical memory and general knowledge: Extensions of the revelation effect. *Memory & Cognition*, *30*, 432–438.
- Betz, A. L., Skowronski, J. J., & Ostrom, T. M. (1996). Shared realities: Social influence and stimulus memory. *Social Cognition*, *14*, 113–140.
- Brehm, J. W. (1959). Increasing cognitive dissonance by a fait accompli. *Journal of Abnormal & Social Psychology*, *58*, 379–382.
- Cappella, J. N., Yzer, M., & Fishbein, M. (2003). Using beliefs about positive and negative consequences as the basis for designing message interventions for lowering risky behavior. In D. Romer (Ed.), *Reducing adolescent risk* (pp. 210–219). Thousand Oaks, Ca: Sage Publications.
- Collins, H. R. (2001). *Another reason to dislike Chihuahuas and other small dogs: Behavioral consequences of false memories*. Unpublished honors thesis, University of Washington, Seattle.
- Fazio, R. H., & Zanna, M. P. (1978). On the predictive validity of attitudes: The roles of direct experience and confidence. *Journal of Personality*, *46*, 228–243.
- Fazio, R. H., Powell, M. C., & Williams, C. J. (1989). The role of attitude accessibility in the attitude-to-behavior process. *Journal of Consumer Research*, *16*, 280–288.
- Garcia, J., Kimeldorf, D. J., & Koelling, R. A. (1955). Conditioned aversion to saccharin resulting from exposure to gamma radiation. *Science*, *122*, 157–158.
- Garcia, J. & Koelling, R.A. (1966). Relation of cue to consequence in avoidance learning. *Psychonomic Science*, *4*, 123–124.
- Garry, M., Manning, C., Loftus, E. F., & Sherman, S. J. (1996). Imagination inflation: Imagining a childhood event inflates confidence that it occurred. *Psychonomic Bulletin and Review*, *3*, 208–214.
- Goff, L.M., & Roediger, H.L (1998). Imagination inflation for action events: Repeated imaginings lead to illusory recollections. *Memory & Cognition*, *26*, 20–33.
- Greenwald, A.G. (1975). On the inconclusiveness of crucial cognitive tests of dissonance versus self-perception theories. *Journal of Experimental Social Psychology*, *11*, 490–499.
- Holland, P.C. (1981). Acquisition of representation-mediated conditioned food aversions. *Learning and Motivation*, *12*, 1–18.
- Hyman, I. E., Jr., Husband, T. H., & Billings, F. J. (1995). False memories of childhood experiences. *Applied Cognitive Psychology*, *9*, 181–197.
- Kelman, H.C., & Hovland, C.I. (1953). "Reinstatement" of the communicator in delayed measurement of opinion change. *Journal of Abnormal & Social Psychology*, *48*, 327–335.

- Loftus, E.F. (2001). Imagination and its memory-making power. *The Psychologist*, *14*, 584–587.
- Loftus, E.F., & Bernstein, D.M. (2005). Rich false memories: The royal road to success. In A. Healy (Ed.), *Experimental Cognitive Psychology and its Applications* (pp. 101–113). Washington DC: American Psychological Association Press.
- Loftus, E. F., & Ketcham, K. (1994). *The Myth of Repressed Memory*. NY: St. Martin's Press.
- Loftus, E.F. & Mazzoni, G.A.L. (1998). Using imagination and personalized suggestion to change people. *Behavior Therapy*, *29*, 691–706.
- Loftus, E. F. & Palmer, J. C. (1974). Reconstruction of automobile destruction: An example of interaction between language and memory. *Journal of Verbal Learning and Verbal Behavior*, *13*, 585–589.
- Loftus, E. F., & Pickrell, J. E. (1995). The formation of false memories. *Psychiatric Annals*, *25*, 720–725.
- Manning, C. G. (2000). *Imagination inflation with posttest delays: How long will it last?* Unpublished doctoral dissertation, University of Washington.
- Mazzoni, G.A.L., & Loftus, E.F (1998). Dream interpretation can change beliefs about the past. *Psychotherapy*, *35*, 177–187.
- Mazzoni, G.A.L., Loftus, E.F., & Kirsch, I. (2001). Changing beliefs about implausible autobiographical events: A little plausibility goes a long way. *Journal of Experimental Psychology: Applied*, *7*, 51–59.
- Mazzoni, G., & Memon, A. (2003). Imagination can create false autobiographical memories. *Psychological Science*, *14*, 186–188.
- Pickrell, J. E., Bernstein, D. M., & Loftus, E. F. (2004). The misinformation effect. In R. F. Pohl (Ed.), *Cognitive illusions: A handbook on fallacies and biases in thinking, judgment and memory* (pp. 345-361). HOVE, UK & NY: Psychology Press.
- Pratkanis, A. R., Greewald, A. G., Leippe, M. R. & Baumgardner, M. H. (1988). In search of reliable persuasion effects: III. The sleeper effect is dead: Long live the sleeper effect. *Journal of Personality & Social Psychology*, *54*, 203–218.
- Siepel, T. (1997, Mar 31). Leader's health tied to deaths. San Jose Mercury News. <http://www.sacred-texts.com/ufo/39dead16.htm>, accessed June 24, 2003.
- Wade, K. A., Garry, M., Read, J. D., & Lindsay, D. S. (2002). A picture is worth a thousand lies: Using false photographs to create false childhood memories. *Psychonomic Bulletin and Review*, *9*, 597–603.
- Zimbardo, P. G., Weisenberg, M., Firestone, I., & Levy, B. (1965). Communicator effectiveness in producing public conformity and private attitude change. *Journal of Personality*, *33*, 233–255.