

Does a Surprising Outcome Reinforce or Reverse the Hindsight Bias?

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There are conflicting hypotheses regarding the effect of a surprising outcome on hindsight judgment. According to the hypothesis presented in this paper, high levels of surprise will lead to the elimination or reversal of hindsight bias. The feeling of surprise serves as a cue to subjects making them aware of the fact that outcome information is largely different from whatever they knew about the event. Subjects under these conditions seek explanations to the outcome and “effortless assimilation,” the most accepted theoretical account for the hindsight bias, is less likely. The alternative hypothesis postulates that surprising outcomes will lead to reinforcement of hindsight bias. The results of three experiments conducted in the framework of the present study indicate that when surprise levels are moderate or low, judgments are consistent with the hindsight bias, whereas highly surprising outcomes lead to the reversal of the bias. © 1997 Academic Press

Hindsight bias, identified and documented by Fischhoff (1975), refers to the tendency to judge events as more predictable when outcome information is known. The importance of this bias stems from its distorting effect on the ability to learn from the past and the potential underestimation of the informativeness of facts. Hindsight bias has been demonstrated in judgments of political, historical, social, and medical events (e.g., Detmer, Fryback & Gassner, 1978; Fischhoff, 1977; Fischhoff, 1980; Fischhoff & Beyth, 1975; Leary, 1981; Powell, 1988; Slovic & Fischhoff, 1977; Synodinas, 1986). Christensen-Szalanski and Williams (1991) meta analysis of 128 studies demonstrated the robustness of this bias.

Fischhoff's (1975) theoretical basis for hindsight bias is generally accepted by most researchers in this area. According to this theoretical account, “upon receipt of

outcome knowledge, judges immediately assimilate it with what they already know about the event in question” (Fischhoff, 1975, p. 297), and the outcome information is effortlessly assimilated in the schematic representation of the domain in question. Consistent with this view, Slovic and Fischhoff (1977) demonstrated that outcome information is not so surprising in hindsight. The perceiver, who assimilates the outcome information naturally and effortlessly, is unaware of its effects and is not surprised in hindsight. Hence, the reaction “I knew it all along.”

On the other hand, in their investigation of the role of surprising outcomes in hindsight judgments, Mazursky and Ofir (1990) hypothesized that highly surprising outcomes would be associated with reactions such as “I could not have expected this to happen” and, therefore, not only might hindsight predictions not be in line with classical hindsight bias, but the bias might be eliminated or even reversed. From a theoretical viewpoint, they noted that surprising outcomes trigger “special processing.” It has been postulated that processing of this type stems from attempts to explain unexpected incongruent behaviors (Hastie, 1984) or, more generally, from engaging in a causal search to explain event outcomes (Weiner, 1985). For example, Srull (1981) noted that incongruent behaviors were recalled better than congruent behaviors. Pyszczynski and Greenberg (1981) identified a tendency to offer a relatively large number of excuses and justifications upon receipt of expectancy-disconfirming information. Mazursky and Ofir (1990) proposed that the feeling of surprise following the receipt of outcome information and the related reinforcing processes may result in the reaction, “I could not have expected it to happen.”

In contrast to the above “reversal” hypothesis, Schkade and Kilbourne (1991) posited that a surprising disconfirming outcome would lead to the reinforcement of hindsight bias. The degree of disconfirmation was hypothesized as moderating the degree of hindsight bias: Thus, the higher the perceived disconfirmation and surprise, the higher the degree of the hindsight bias (pp. 109–110). In view of the robustness of the

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hindsight bias (e.g., Fischhoff, 1982), findings supporting its existence, such as those reported by Schkade and Kilbourne (1991), can hardly be disputed. However, if the surprise levels in their experiments did not reach a needed threshold, judgments in line with the hindsight bias would be expected. *Unfortunately, neither surprise levels nor perceived disconfirmation were measured in their experiments and, therefore, this manipulation could not be assessed.*

Indeed, if outcome information is only moderately surprising or not surprising at all, hindsight bias effects are expected; that is, judgments consistent with the reaction, "I knew it all along," as envisioned by Fischhoff. There is no reason or evidence at this point to suggest that the processes leading to assimilation of outcome information are interrupted. On the contrary, the "effortless" assimilation process suggested by Fischhoff seems to be a quite plausible explanation in the case of unsurprising outcome information. That such a process is likely to operate, has been demonstrated in Fischhoff's (1975) study and many other related replications.

If the outcome is highly surprising, however, the feeling of surprise along with the cognitive effort invested in explaining the outcome, may serve to signal "I could not have known it." Acknowledged surprise alerts the perceiver to the gap between the outcome information and his/her assumed knowledge about the event. Given the feeling of surprise and the cognitive effort invested in the search for explanations and causal reasons for the outcome, it is less likely that "effortless" and "natural" restructuring of domain knowledge will occur, as in the case of a less surprising outcome. Acknowledged surprise serves as a cue that the outcome could not have been foreseen. Surprising outcome information may lead people to reflect their overall reaction regarding the inability to foresee the outcome by reducing the predictability of its occurrence. Acknowledged surprise, therefore, is hypothesized to be associated with the elimination or even the reversal of the hindsight bias.

Thus, we propose the following role of surprise in hindsight judgments: If outcomes are only moderately surprising or not surprising at all, it is hypothesized that judgments will be in line with the outcome information. It may well be that moderate inconsistency and disconfirmation can be resolved with minimal cognitive effort and integrated into the knowledge representation of the event. If, however, the outcome is highly surprising, we expect the hindsight bias to be eliminated or even reversed.

The main objective of this study is to examine the role of surprise in hindsight probabilistic judgments and to test the above two opposing hypotheses. To this

end, we conducted three experiments examining various aspects of our extended framework. We demonstrated that in the face of highly surprising outcomes, hindsight probability estimates shift in the opposite direction to the outcome (i.e., the reversal hypothesis) and, conversely, when the level of surprise is lower, hindsight probability estimates shift in the direction of the outcome (i.e., the hindsight bias). Experiment 1 and Experiment 2 examine the reversal effect using two different experimental settings and stimuli. Experiment 3 includes additional experimentation and analyses testing both the hindsight bias and its reversal. In line with the standard hindsight bias experimental procedure, experimental subjects were asked to ignore outcome information when providing their judgments. The results indicate that relatively nonsurprised subjects provide hindsight probability estimates that are in line with classical hindsight bias whereas hindsight predictions made by highly surprised subjects are consistent with the reaction, "I could not have expected this to happen." Various methodological concerns and alternative explanations are addressed and discussed along with the accommodation of related findings within the extended framework.

EXPERIMENT 1

Method

Subjects. Subjects were 70 undergraduate students at the Rothberg School of Overseas Students at the Hebrew University. Subjects were recruited individually and compensated for their participation.

Procedure and design. Subjects were presented with information regarding a man with a heart condition whose doctor had recommended a bypass operation. Subjects were also informed that 2% of such patients die from the operation itself. Subjects were randomly assigned to three groups: one experimental and two control conditions. Subjects in the experimental condition were informed that the operation had failed and the man had died. These subjects were asked to predict the probability of the success of the operation and to provide disconfirmation and surprise ratings. Following other experiments in the hindsight research paradigm (e.g. Fischhoff, 1975), 24 experimental subjects who received the outcome were asked to ignore the outcome information when providing their judgments. In the first control group (henceforth, outcome control), 24 subjects were told the outcome and asked to provide only disconfirmation and surprise ratings. This control group served to test the hypothesis that surprise ratings may be influenced by other measures. In the second control group (henceforth, the no-outcome

control), 22 subjects did not receive any outcome information. These subjects were only asked to predict the probability of the success of the operation. The results obtained for this control group were compared with the results obtained for the experimental group to test for hindsight bias or its reversal.

Stimulus material. The following modified "heart condition" problem (Baron & Hershey 1988) was presented to the experimental group and the outcome control group: "A 55-year-old man was suffering from a heart condition. He had to stop working due to chest pain. He enjoyed his work and did not want to stop. His pain also interfered with other activities, such as travel and recreation. A type of bypass operation would relieve his pain and increase his life expectancy from 65 to 70. However, 2% of the people who undergo this operation die from the operation itself. His physician recommended to go ahead with the operation. This physician had no problems in the past diagnosing and advising his patients on similar medical issues. The operation was carried out by the experienced staff of a large hospital. The operation failed and the man died."

No-outcome subjects were asked to provide predictions in probabilities (0–100) regarding the success of the man's operation. Experimental subjects were asked to predict the success of the operation "as they would have, had they not known the outcome" (Fischhoff, 1975, p. 293). Subjects in the experimental group and the outcome control group were also asked to indicate the degree to which their expectations were disconfirmed on a seven-point scale: "The outcome of the operation is:" (1 = Worse than expected; 4 = As expected; 7 = Better than expected). They were also asked to indicate their surprise at the outcome (1 = Not surprised at all; 7 = Very surprised).

Results and Discussion

Preliminary analysis. The surprise ratings of experimental and outcome control subjects were not significantly different ($t(46) < 1$). Nor were their disconfirmation ratings significantly different ($t(46) < 1$). Providing probability judgments before surprise and disconfirmation ratings did not affect the latter. Subjects in both groups were surprised and the outcome disconfirmed their expectations.

Hindsight predictions. The results are in line with the prediction that a surprising outcome will either eliminate or reverse the direction of the hindsight bias: Predictions in the experimental cell were significantly higher (mean = 97.2; median = 98.0) than those in the no-outcome control group (mean = 93.1, median = 96.5), ($t(44) = 2.62, p < .01$). Although one might expect a 98% success rate prediction in the no-outcome control

group, the lower prediction is in line with empirical evidence (Lynch & Ofir, 1988) suggesting that when only the (high) prior is presented, judgments based upon it are somewhat less extreme. Experimental subjects who were provided with the outcome did not expect the patient to die, with a mean disconfirmation of 1.65 (level one on the 7-point disconfirmation scale was labeled "Worse than expected"). These subjects were also quite surprised (mean = 5.29 on the 7-point scale). Their predictions were significantly higher than those of no-outcome control subjects. The classical bias would imply hindsight judgments (experimental group) to be lower than foresight judgments (no-outcome control). The key to understanding the results obtained for the experimental subjects is their disconfirmation and surprise at the outcome leading to a reaction of the type "I could not have expected the man to die," and hence, higher rather than lower hindsight predictions. Experiment 2 generalizes this finding using a different experimental stimulus and setting.

EXPERIMENT 2

Method

Procedure and design. Fifty-eight patients, all with prior experience with a specific brand of mouthwash, were invited to participate in the experiment while awaiting treatment in a dental clinic. Respondents were randomly assigned to two groups, 31 to the experimental group and 27 to the control group. All subjects were shown a copy of an advertisement promoting the focal brand for about 3 min. The main message conveyed by the advertisement was that the brand removes plaque. More explanations reinforcing the main message were given in smaller print. Subjects in the experimental group were given additional information regarding a research project conducted in a leading university which had found that regular water was as effective as this particular brand in removing plaque and that both treatments (regular water and this particular brand) were ineffective in removing plaque. This outcome, according to a pretest, was perceived as surprising. Control subjects were not given any information regarding the effectiveness of the brand. Subjects in both groups were presented with a short questionnaire. Finally, all subjects were debriefed.

Stimulus material. Subjects in the experimental and control groups were shown an advertisement promoting the mouthwash. The heading announced that "Brand X removes plaque." This message was reinforced by informing subjects that plaque is a layer of bacteria which sticks to the teeth and that it is the main cause of cavities, gum infection, and tartar

buildup. They were told that as the toothbrush cannot get to all of the hard-to-reach places, brushing alone cannot fight plaque, and the plaque just stays on the teeth. The advertisement claimed that if Brand X is used before brushing teeth, it removes plaque, maintains oral hygiene, and fights diseases caused by plaque.

Subjects in the experimental group were also informed, on a separate page, that extensive research had been conducted in a medical school of a leading university to assess the effectiveness of Brand X in removing plaque and preventing gum disease. Hundreds of families using the focal brand, as well as a large group of families using regular water to rinse their mouth, had been monitored and checked. The subjects were told that the research results clearly demonstrated that regular water was as effective as the focal brand in removing plaque and preventing gum disease, and that the effectiveness of both was found to be very low.

Dependent measures. Both groups were given a short questionnaire. Subjects in the experimental group were instructed to ignore the information regarding the research and its results when answering the prediction question. Experimental subjects were asked to ignore outcome information when providing the judgment for the question, "what is the probability in percentages that regular everyday usage of Brand X is effective in removing plaque?" Experimental subjects were also asked to indicate their surprise regarding the results of the research on a 7-point scale (1 = Not surprised at all, 7 = Very surprised). Control subjects were asked to provide the prediction only.

Results and Discussion

Subjects in the experimental group expressed surprise at the research results (mean = 6.1 on the 7-point scale). Their predictions regarding the effectiveness of the brand in removing plaque were quite high (mean = 77.6%; median = 80%). In contrast, and as hypothesized, the control subjects provided significantly lower predictions (mean = 61.8%, median = 60%) than the experimental subjects ($t(56) = 2.61, p < .02$). Note that the results in the experimental group were obtained after the subjects had received information indicating the opposite outcome. Thus, the results demonstrate quite strongly that the finding of the research project provided to the experimental subjects significantly influenced their hindsight predictions. The predictions provided by the experimental subjects (who were surprised by the outcome) were significantly higher in hindsight than the predictions of the control subjects. In line with the results and conclusions of Experiment

1, these results are consistent with the reaction "I could not have expected this outcome" and, as hypothesized, demonstrate reversal of hindsight bias.

EXPERIMENT 3

Method

Subjects. Subjects were 242 American undergraduate students at the Rothberg School for Overseas Students at the Hebrew University. Subjects were recruited individually and they were compensated for their participation.

Procedure, design, and stimuli. The experiment involved two experimental groups and two control groups. Subjects in all groups were shown a copy of a painting and told to examine it carefully. They were asked to indicate the probability that one of the following had painted the picture: (1) A 12-year old boy, (2) Picasso, (3) Renoir, and, (4) Other—none of the above. Subjects were instructed that their probabilistic judgments had to add up to 100. Experimental subjects were asked to ignore outcome information when providing their judgments and to provide surprise ratings.

After being shown the painting and before providing the prediction, 66 subjects in the first experimental cell were told that the painter was Picasso. Seventy-six subjects in the second experimental cell were told that the painter was not Picasso, not Renoir, and not a 12-year old boy (i.e., the correct answer was "Other"). The painting chosen for this experiment was undistinguished. Revealing the identity of the painter (i.e., Picasso) was expected to be surprising. In contrast, revealing that the picture was not painted by Picasso, Renoir, or a 12-year old boy (in the second experimental cell) was expected to be relatively unsurprising. Subjects in the two experimental groups were asked to ignore the outcome information when providing their judgments.

In one of the two control groups, subjects were not given any outcome information. These (72) subjects were requested to give predictions only. The objective of this no-outcome control group was to provide the foresight judgments needed for comparison with hindsight judgments in the two experimental groups. In the second control group, subjects were told that Picasso had painted the picture. These (28) subjects were required only to rate their surprise at the outcome on a 7-point scale (1 = Not surprised at all; 7 = Very surprised). This control group enabled further testing of the hypothesis that surprise ratings may be influenced by other measures.

Results and Discussion

Preliminary analysis. In order to rule out the possibility of predictions affecting the rating of surprise, surprise at the Picasso outcome in the first experimental and the outcome-control cell was compared. No significant difference in mean surprise was found between the two groups ($t(91) = -.65$, n.s.).

Predictions in hindsight and foresight. Predictions for the two experimental cells and the no-outcome control cell are presented in Table 1. The columns in Table 1 represent the two experimental groups (the "Picasso" outcome group and the "Other" outcome group) and the no-outcome control group. The rows in Table 1 display the prediction probabilities of the four outcome options. We expected that due to high surprise, subjects who were informed that Picasso was the artist would indicate lower hindsight probabilities than would control subjects who were not informed about the outcome (see the bold figures in columns 1 and 3 corresponding to the Picasso option in the second row). Conversely, we expected that due to low level of surprise, subjects who were informed that the outcome was Other would assign higher hindsight probability than would no-outcome control subjects (see the bold figures in columns 2 and 3 corresponding to the Other option in the fourth row).

Indeed, examination of the means suggests that providing the Picasso outcome eliminates hindsight bias, and the predictions are in the reversal direction. In contrast, and in line with the hindsight bias, providing subjects with the Other outcome leads to higher predictions than those provided by no-outcome control subjects. A more detailed statistical analysis is provided below.

The outcome that neither Picasso, Renoir, nor a 12-year old boy had painted the picture was perceived as unsurprising (mean = 2.9 on a 7-point scale). This outcome demonstrates the classical hindsight effect as envisioned by Fischhoff (1975): The mean prediction that Other had painted the picture was 43.4% (median = 38.0) in the experimental group vs 28.8% (median = 22.5) in the no-outcome control group (Mann-Whitney U test, $p < .003$).¹ The Other outcome, as expected, was perceived as unsurprising and experimental subjects provided higher predictions than no-outcome control subjects. This result is consistent with hindsight bias.

The Picasso outcome was perceived as quite surprising (mean = 5.01). In this case, predictions were not

¹ Some concern exists regarding the usage of parametric statistics in this type of problem because each prediction within outcome group is constrained by other judgments (Fischhoff, 1975). Non-parametric statistics are therefore used.

TABLE 1

Evaluated possibilities	Group according to outcome provided		
	Picasso	Other	Control: No outcome
A 12-year old boy	52.1	35.7	44.1
Picasso	14.0	12.3	19.3
Renoir	8.1	8.4	7.9
Other	25.5	43.4	28.8

consistent with the classical hindsight bias. In fact, the bias was eliminated: Mean predictions in the experimental group were 14.04 vs 19.26 in the control group (Mann-Whitney U test—not significant). It may well be that this level of surprise is sufficient to eliminate the bias but not to reverse it. Note that the hindsight judgments are in the opposite direction to that predicted by the hindsight bias.

In order to further investigate this experimental group (Picasso outcome), subjects were split according to their surprise ratings, with the median surprise rating (5 on a 7-point scale) serving as the cutoff point. According to our hypothesis, the predictions of subjects who were surprised were expected to be significantly lower than those of subjects who were not surprised. The results are consistent with this hypothesis (see Table 2). The predictions of experimental subjects who were surprised were significantly lower (mean probability = 5.7, median = 1.0; $n = 41$) than those of subjects who were not surprised (mean probability = 28.7, median = 30.0; $n = 24$) (Mann-Whitney U test, $p < .0001$). As intended by the split, one group (mean = 6.3) was significantly more surprised than the other group (mean = 2.6), ($t(63) = 14.6$, $p < .0001$). Moreover, the predictions of subjects who were surprised were significantly lower than those of no-outcome control subjects (Mann-Whitney U test, $p < .003$). This finding suggests reversal of the bias. In contrast, the predictions of subjects who were not surprised were significantly higher than those of no-outcome control subjects (means: 28.7 vs 19.3; medians 30.0 vs 10.0), (Mann-Whitney U test, $p < .001$). This finding is in line with the classical hindsight bias.

TABLE 2

	Picasso group 1	Picasso group 2	Control: No outcome
Surprise (7-point scale)	6.3	2.6	—
Predictions (probabilities)	5.7	28.7	19.3

These results support the hypothesis that surprising outcomes eliminate the hindsight bias. Moreover, after the split, highly surprised subjects provided predictions suggesting reversal of the bias, whereas subjects who were not surprised exhibited the classical hindsight bias. In addition, the Other outcome, which was perceived as unsurprising, was associated with classical hindsight predictions.

GENERAL DISCUSSION

Surprising Outcome and Predictions in Hindsight and Foresight

The highly unexpected 1987 stock market crash has served as the context for the portrayal of two alternative retrospective responses. Schkade and Kilbourne (1991) suggested that decision makers may be prone to hindsight bias in that they tend to exaggerate the a priori predictability of the behavior of the stock market. Conversely, Mazursky and Ofir (1990) cited the statement “. . . in my wildest dreams I would not have imagined this” (Richard Barris, *New York Times*, October 20, 1987) which is inconsistent with the hindsight bias tendency. Such a response to an acknowledged surprising outcome may result in either the elimination of the hindsight bias or its reversal.

Fischhoff's (1975) theoretical explanation for the hindsight bias has been adopted by most researchers. Outcome information, according to Fischhoff (1975), assimilates with the schematic representation of the event or domain knowledge. This process, termed by Fischhoff “creeping determinism,” is “natural” and “effortless” (Fischhoff, 1975). Slovic and Fischhoff (1977) have also demonstrated that outcomes in hindsight are not so surprising.

Schkade and Kilbourne (1991) hypothesized that a surprising outcome would lead to reinforcement of the bias. The empirical evidence presented in this paper rejects this latter hypothesis. Schkade and Kilbourne's (1991) findings supporting the hindsight bias are in line with many studies demonstrating the robustness of the hindsight bias. However, *in the absence of any measurement of the level of surprise experienced by subjects, it is difficult to interpret their findings*. It may well be that the outcomes used in their experiments were not sufficiently surprising or that they did not reach the threshold of surprise needed in order to demonstrate the elimination or reversal of the bias. Indeed, if the outcomes in these experiments were not highly surprising, hindsight bias would be expected.

Various manipulation checks indicated that the outcomes used in the experiments presented in this paper

were perceived to be quite surprising. Surprising outcomes are associated with more attempts at explanation, justification, and better recall of incongruent evidence than confirming outcomes. Surprise is acknowledged and serves as cue to the fact that the outcome information is largely different from what is known about the event. “Effortless assimilation” is therefore unlikely in the face of a surprising outcome. The experiments presented here indicate that acknowledged surprise is associated with judgments that are not biased in the direction of the outcome. In other words, given a surprising outcome, the hindsight bias is eliminated or even reversed.

Potential methodological problems. Some concern may exist regarding the scale employed to demonstrate the hindsight bias. This is particularly relevant to a previous study demonstrating the reversal of the bias (Mazursky & Ofir, 1990): Can rating scales measuring subjective uncertainty be used instead of the subjective probability scale (0–100) to investigate the hindsight bias? Are these rating scales reliable and valid? Might these scales bias the results? Recent research conducted by Ofir and Reddy (1996) comparing rating scales and the subjective probability scale suggests that rating scales are reliable and that their method variance is minimal. In fact, from a psychometric perspective, rating scales performed better than the classical subjective probability scale (Ofir & Reddy, 1996). Rating scales have been used previously in research focusing on the hindsight bias and related paradigms (e.g., Creyer & Ross 1993). The results of the current investigation based on the subjective probability scale, which support our previous investigation based on a seven-point likelihood rating scale, suggest that a surprising outcome either eliminates or reverses the hindsight bias. The similarity between the results based on both types of scale suggests that they both measure the same underlying construct of subjective uncertainty.

The question whether the response format of rating scales might bias the results is problematic and deserves attention. Research has shown that the design and wording of scales can affect the results (e.g., Guilford, 1954; Nunnally, 1967; Ofir & Reddy, 1996). For example, in the hindsight paradigm, Mark and Mellor (1991) employed a three-category scale in a task investigating the foreseeability of being laid off. They measured reactions associated with the hindsight bias using the following three response categories: “I'm not sure I ever saw it coming;” “I wasn't sure, but suspected it was coming;” and “I saw it coming all the way” (p. 571). This is not a scale measuring uncertainty. Moreover, this scale is unbalanced in that it does not allow for the measurement of reactions in the opposite direction

to hindsight bias. The addition of the following categories, for example: "I did not see it coming" and "I am certain I could not have seen it coming" would have served to balance this rating scale, provide a more informative response spectrum, and enable valid, unbiased measurement of hindsight related effects.

Summary

Converging evidence for the conclusion that highly surprising outcomes are associated with hindsight expectations in the opposite direction to the outcome is afforded by the pattern of judgments obtained in all three experiments reported in the present study. In light of these findings and the substantial body of empirical evidence supporting the classical hindsight bias reported in the literature and reaffirmed in the present study, it appears that both reactions are possible. The present findings lend support to an extended framework of hindsight predictions which accommodates either possibility: When the outcome is relatively unsurprising, the "I knew it all along" reaction is posited and hindsight predictions shift in the direction of the outcome. Conversely, when the outcome is highly surprising, an "I could not have expected it" reaction results in a shift of the hindsight prediction in the direction opposite to the outcome.

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