

## THEORETICAL NOTE

# The Reiteration Effect in Hindsight Bias

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Repetition of an assertion increases the degree of belief in that assertion. This reiteration effect is used to explain two puzzling findings in research on hindsight bias. First, the reiteration effect explains the asymmetry in hindsight bias for true and false assertions. This striking asymmetry has often been observed in experimental studies, but no rationale has yet been found. Second, the reiteration effect predicts a novel finding: Recalled confidence will increase in hindsight bias studies even if no feedback is given. The authors have checked both predictions against results reported in the literature; with some exceptions, the evidence supports them.

The aim of this article is to relate two hitherto unrelated phenomena in human confidence. These two phenomena are that (a) confidence in the truth of an assertion increases after the assertion is repeated, independent of its truth or falsity (e.g., Bacon, 1979; Hasher, Goldstein, & Toppino, 1977), and (b) recollection of confidence is systematically distorted after feedback about the actual truth or falsity has been received (known as "hindsight bias," e.g., Hawkins & Hastie, 1990). The effects of repetition and feedback on confidence are part of a group of puzzling phenomena related to human confidence that includes overconfidence, the hard-easy effect, and conservatism. Some two decades of research have yielded a rich phenomenology of these effects but have failed to produce theoretical models to describe the underlying cognitive processes. A consequence of this is that these phenomena are listed in textbooks side by side with little or no theoretical integration.

This article seeks to provide a model for how two of these phenomena—the effect of repetition (which we term the *reiteration effect*) and the effect of feedback on confidence (the *hindsight bias*)—are linked. This article consists of three sections: a brief introduction of the reiteration effect and the hindsight bias; an exposition of the proposed model, including two predictions; and a test of these predictions.

### The Reiteration Effect

"Ceterum censeo Carthaginem esse delendam." The Roman statesman Cato is said to have reiterated this call to destroy

Carthage at the end of each of his speeches. This repeated call became reality when the Romans destroyed Carthage in 146 B.C. As Gustave Le Bon observed in his book *Psychologie des Foules* (1895/1995), an "affirmation, however, has no real influence unless it be constantly repeated, and so far as possible in the same terms. It was Napoleon, I believe, who said that there is only one figure in rhetoric of serious importance, namely, repetition. The thing affirmed comes by repetition to fix itself in the mind in such a way that it is accepted in the end as a demonstrated truth" (pp. 146–147). This rhetorical principle—reiterating assertions to make them more believable—has been known and exploited by innumerable real and fictitious communicators throughout history, for instance, by Quintilian (quoted in Lausberg, 1990, p. 311), Ronald Reagan (Herts-gaard, 1988, p. 49), and Marcus Antonius in Shakespeare's *Julius Caesar* (3.2.73–107).

In the last 20 years the relationship between repetition and degree of belief has been independently rediscovered in psychological laboratories and put to experimental test. Hasher et al. (1977) seem to have been the first to demonstrate that (a) repetition of an assertion increases the confidence in its truth and (b) the increase in confidence is independent of the actual truth or falsity of the assertion.<sup>1</sup> In their study, participants were asked to rate plausible general knowledge assertions (e.g., "The People's Republic of China was founded in 1947") in three sessions, each separated by a 2-week interval. During the sessions, participants rated the validity of 60 assertions on a 7-point scale. Of those, 20 were repeated assertions that were presented in each of the three sessions; the remaining 40 were new to each session. Henceforth we will refer to this type of design as the *reiteration design*.

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This research was supported by the Deutsche Forschungsgemeinschaft Grant HE 1491/2-2.

We would like to thank Larry Barsalou, Hartmut Blank, Valerie Chase, Berna Eden, Dan Goldstein, Scott Hawkins, Wolfgang Hell, Asher Kori-riat, Laura Martignon, Peter Sedlmeier, Anita Todd, and Tom Trabasso for helpful comments.

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<sup>1</sup> In research on both the reiteration effect and hindsight bias, participants' judgments have been variously labeled as "validity" ratings (Hasher et al., 1977), "truth" ratings (Bacon, 1979), "truth value" ratings (Schwartz, 1982), "probability" ratings (Fischhoff, 1977), "plausibility" ratings (Wood, 1978), and "certainty" ratings (Sharpe & Adair, 1993). We use the general term *confidence judgment* because it is an established term to denote people's degrees of beliefs (Gigerenzer, Hoffrage, & Kleinbölting, 1991) and can be applied to both hindsight bias and reiteration research.

Hasher et al. (1977) concluded that in a situation in which no information is available about the actual truth or falsity of an assertion, the mind infers the confidence in the truth of the assertion from the frequency of occurrence. More specifically, Hasher and her colleagues (e.g., Hasher & Chromiak, 1977; Hasher & Zacks, 1979; Hasher & Zacks, 1984; Zacks, Hasher, & Sanft, 1982) have claimed that frequencies of occurrence are encoded automatically, with little to no attentional capacity. In this view, frequency is one of the few attributes (besides spatial location, temporal information, and word meaning) that seems to be encoded automatically (for the limits of the notion of automatic encoding, see Barsalou, 1992, chap. 4). Hasher et al.'s (1977) findings were replicated using very short intervals between repetitions (Schwartz, 1982) and in settings outside of the laboratory, with the general public (Gigerenzer, 1984).

Bacon (1979) suggested that it is not objective frequency per se that increases confidence, but whether an assertion is merely recognized as old (repeated) or new (not repeated). According to this view, the confidence in an assertion's truth will only increase if it is recognized as old. The experimental results reported by Bacon (1979) and Arkes, Hackett, and Boehm (1989, Experiment 1A) support such a memory variant of the reiteration effect: Mean confidence increased when the assertions were recognized as old, independent of whether or not the assertions were actually repeated. More recently, though, it has been proposed that the reiteration effect is a function of an assertion's familiarity and that "familiarity increases automatically with repetition" (Begg, Anas, & Farinacci, 1992, p. 447).

The issue of whether confidence is a function of objective or remembered repetition, while controversial, does not affect the present thesis that the reiteration effect is part of what is commonly called the hindsight bias. In studies of hindsight bias, actual repetitions are always identified as "old" because participants are asked to recall their original confidence in the truth of an assertion; that is, in hindsight bias studies, participants never recall confidence for "new" assertions.

In the recent psychological literature, the effect of repetition has had various labels, such as "frequency-validity relationship" (Gigerenzer, 1984) and "illusory-truth effect" (Begg et al., 1992). For the sake of brevity, we will use the term reiteration effect.

### The Hindsight Bias

Two experimental designs, memory design and hypothetical design, have been employed to study the hindsight bias. The findings obtained through these experimental designs have been variously referred to as *hindsight bias* and the *knew-it-all-along effect*. We have confined our use of the term hindsight bias to the effect reported in designs in which memory judgments are studied and use the term knew-it-all-along effect for designs in which hypothetical judgments are studied. We use these definitions throughout, referring to the two designs as the *hindsight design* and the *knew-it-all-along design*.

Several types of responses have been investigated in previous hindsight bias studies; here we are concerned only with confidence judgments in the truth of an assertion. Participants are given a series of assertions and asked to state their confidence that each of them is true (henceforth, *original confidence*). They

are later given feedback (i.e., the truth values) for a subset of these assertions and, finally, are asked to recall their original confidence (henceforth, *recalled confidence*). For instance, Wood (1978) presented assertions such as "Prohibition was called the noble experiment," and participants were asked to state their confidence that each of the assertions was true. After feedback was given (the assertion "Prohibition was called the noble experiment" is true), participants were asked to recall their original confidence. The typical result reported in the literature was that after "true" feedback recalled confidences are higher than original confidences and after "false" feedback recalled confidences are lower than original confidences. This effect is known as the hindsight bias. The recalled confidences in assertions for which the participants did not receive feedback are used as controls.

In the knew-it-all-along design, in contrast, participants first receive assertions and feedback *without* being asked for an original confidence judgment. They are then asked how confident they would have been in the assertions' truth had they not received feedback. These hypothetical judgments can be compared either to the judgments of other participants who respond to the same assertions, but without feedback (between-subjects design), or to judgments by the same participants who respond to a set of assertions for which they, too, did not receive feedback (within-subjects design). The typical finding is that average hypothetical confidences after feedback are higher (lower) for true (false) assertions compared to confidences without feedback. Thus, participants with feedback tend to overestimate how much they would have known had they not been told the answer, which is termed the knew-it-all-along effect.

The hindsight bias and the knew-it-all-along effect have been variously demonstrated in general knowledge (e.g., Fischhoff, 1977; Hoch & Loewenstein, 1989), political events (e.g., Fischhoff & Beyth, 1975), nuclear-power accidents (Verplanken & Pieters, 1988), or medical diagnoses (e.g., Arkes, Wortmann, Saville, & Harkness, 1981). Hawkins and Hastie (1990) have done a review of the literature, and Christensen-Szalanski and Fobian Willham (1991) have done a meta-analysis of the effect sizes.

For our purpose, the distinction between the hindsight design and the knew-it-all-along design is essential. In the former, the repetition of assertions is part of the experimental procedure, whereas in the latter the assertions are presented only once. This crucial feature of the hindsight design gives rise to predictions that will be derived in the next section.

### A Model of the Reiteration Effect in Hindsight Bias Studies

The reiteration effect and the hindsight bias have been discussed in the literature side by side, but without investigation into the possibility of their theoretical connection. We argue here that the two effects are indeed related: The reiteration effect is part of the hindsight bias reported in previous studies. Our argument applies to hindsight bias studies in which participants are asked about their confidence in the truth of assertions and not to those cases where participants responded to questions (e.g., "What is the length of a hundred-mark bill?" see Hell, Gigerenzer, Gauggel, Mall, & Müller, 1988). The reiteration

effect is produced by the repetition of assertions, not by repetition of questions.

In a reiteration design, assertions are presented on multiple, successive occasions, for each of which the cognitive task is the same: to state confidence in the truth of the assertions. For instance, in Hasher et al.'s (1977) study, there were three such presentations. In a hindsight design, assertions are also presented on multiple occasions, but unlike the reiteration design each presentation demands a different cognitive task. At the first presentation of the assertions, participants are asked for confidence judgments. At the second presentation of the assertions, participants learn about their truth or falsity. At the third presentation, the participants' task is to recall their original confidence judgments (the second and third presentations are often merged). Despite the different cognitive tasks, the repetition of the assertions is common to both experimental designs. Therefore, the reiteration effect could co-occur with the hindsight bias. Thus, our thesis is that recalled confidence in a hindsight design is composed of two effects: (a) the reiteration effect of size  $\alpha$  and (b) the hindsight bias of size  $\beta$ . The sign of the hindsight bias (+, -) depends on type of feedback ("true" or "false"), whereas that of the reiteration effect does not. Therefore, if feedback is "true," the difference between the recalled confidence ( $r_t$ ) and the original confidence ( $o_t$ ; subscript  $t$  means true) can be stated as follows:

$$r_t - o_t = \alpha + \beta. \quad (1)$$

If feedback is "false," the difference between the recalled confidence ( $r_f$ ) and the original confidence ( $o_f$ ) is

$$r_f - o_f = \alpha - \beta. \quad (2)$$

Equations 1 and 2 define the *observed hindsight bias* (i.e.,  $r_t - o_t$  and  $r_f - o_f$ ) as a function of the reiteration effect and the *true hindsight bias*. This is illustrated in Figure 1. For ease of reference, we refer to this model of the reiteration effect in hindsight bias as the *RH model*. This model is simple but allows for two nontrivial predictions.

**Prediction 1:** Asymmetry of observed hindsight bias. The amount of observed hindsight bias is larger for true than for false feedback assertions.

This prediction is derived in the following way: The effects of repetition and feedback on the recalled confidence go in the same direction for true assertions (Equation 1) but take different directions for false assertions (Equation 2). Hence, observed hindsight bias—that is, the change in confidence from original judgment to recalled confidence—will be larger for true than for false assertions. This asymmetry in observed hindsight bias is illustrated in Figure 1. Note that when we speak of "true" (or "false") assertions, we mean assertions for which the experimenter gave the feedback "true" (or "false"), that is, we leave open whether the experimenter gave correct or incorrect feedback.

Prediction 1 has an interesting corollary: Reversals of the observed hindsight bias are likely to occur for false assertions (i.e.,  $r_f > o_f$ ) but not for true assertions (i.e.,  $r_t < o_t$ ). This corollary is derived in the following way: If the reiteration effect

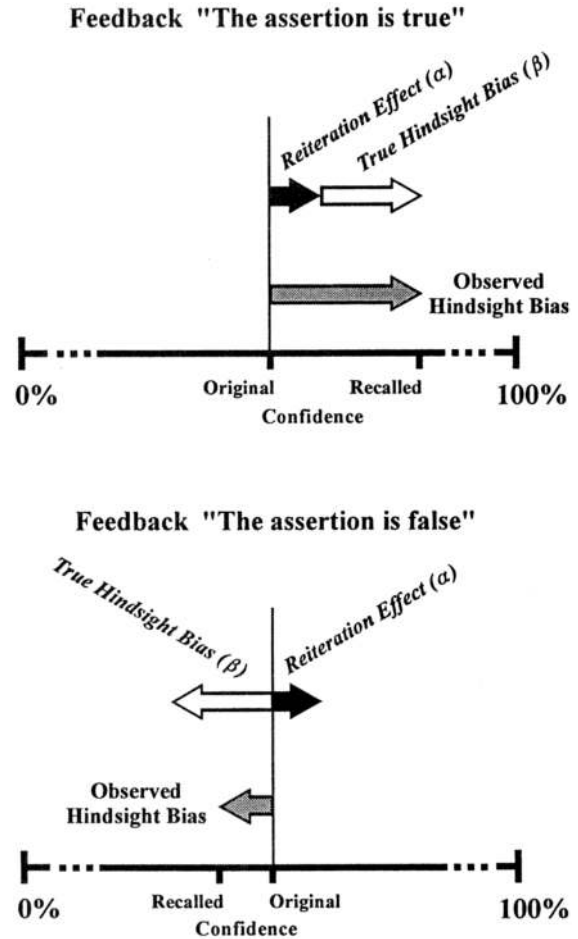


Figure 1. Asymmetry of observed hindsight bias.

is larger than the hindsight bias ( $\alpha > \beta$ ), a reversed observed hindsight bias for false assertions occurs, because the decrease due to hindsight bias ( $\beta$ ) is smaller than the increase due to the reiteration effect ( $\alpha$ ). Reversals for true assertions should be very unlikely, because both effects go in the same direction.

**Prediction 2:** Increase of confidence without feedback in hindsight bias studies. When no feedback about the truth or falsity of the assertions has been provided, recalled confidence is larger than original confidence.

Hindsight designs use assertions with no feedback as a control. In no-feedback assertions, only repetition can affect recalled confidence, because no feedback is provided (i.e.,  $\beta = 0$ ). Because the reiteration effect increases confidence whether assertions are true or false, recalled confidence will be larger than original confidence for the no-feedback (control) assertions in a hindsight design.

Several assumptions are involved in the RH model.

#### Size of True Hindsight Bias

We suggest that observed hindsight bias (as reported in previous studies) is not the same as true hindsight bias (which is

denoted as  $\beta$  in Equations 1 and 2). The observed bias represents the combination of the true hindsight bias and the reiteration effect. The RH model assumes that the size of true hindsight bias is the same, regardless of whether feedback is "true" or "false."

### Size of Reiteration Effect

Some hindsight designs repeated the assertions twice: first when feedback was given and again when the recalled confidence was obtained. Others collapsed presentation of feedback and recollection into one repetition. In the analysis reported below, we have made the simplifying assumption that the size of the reiteration effect (denoted as  $\alpha$  in Equations 1 and 2) is independent of whether there are one or two repetitions. This simplifying assumption is based on the fairly consistent result reported in the literature that the strongest increase in confidence occurs after the first repetition (e.g., Arkes, Boehm, & Xu, 1991; Gigerenzer, 1984; Hasher et al., 1977; Schwartz, 1982; Toppino, Robertshaw, Hasher, & Goldstein, 1977). The same results additionally suggest that the function between the number of repetitions and confidence is strongly negatively accelerated. We have made the further assumption that the size of the reiteration effect is independent of the level of confidence in the original judgment, for which there is some support in the work of Arkes et al. (1989, pp. 84–85).

### Additivity of the Reiteration Effect and the Hindsight Bias

There are several ways to model how the two effects  $\alpha$  and  $\beta$  combine, but given the level of present knowledge and the fact that ours is the first attempt to estimate  $\alpha$  and  $\beta$  quantitatively, we propose a simple, additive combination. If additivity is assumed, then  $\alpha$  and  $\beta$  can be estimated and Prediction 1 quantified as follows: For instance, assume that the observed hindsight bias ( $r_t - o_t$ ) for true assertions is 8 percentage points (on a 0%–100% confidence scale) and the observed hindsight bias ( $r_f - o_f$ ) for false assertions is –4 percentage points. As is shown by Equations (3) and (4), adding these two values results in  $2\alpha$  and subtracting them results in  $2\beta$ .

$$(r_t - o_t) + (r_f - o_f) = (\alpha + \beta) + (\alpha - \beta) = 2\alpha \quad (3)$$

$$(r_t - o_t) - (r_f - o_f) = (\alpha + \beta) - (\alpha - \beta) = 2\beta, \quad (4)$$

where  $(\alpha + \beta)$  specifies the observed hindsight bias for true assertions, and  $(\alpha - \beta)$  specifies the observed hindsight bias for false assertions. That is, in this example we arrive at  $\alpha = 2$  and  $\beta = 6$  percentage points.

In the following section, we will test Predictions 1 and 2 against the available evidence in the literature.

### Test of the Predictions

The two predictions elaborated above can be evaluated in experiments using a hindsight design in which (a) participants state their confidence in the truth of assertions (as opposed to studies in which participants answer questions or choose between several alternatives, none of them being asserted); (b) feedback unequivocally pertains to the original assertion (as

opposed to providing participants with some related information, as in Verplanken & Pieters, 1988); and (c) the amount of the hindsight bias for true and false feedback assertions is reported separately. We found nine studies that satisfy these criteria, which together provide 26 tests of Prediction 1 and 16 tests of Prediction 2.

These studies differed in their goals and in some aspects of experimental design and procedure (e.g., time interval between elicitation of original and recalled confidence). We do not discuss these differences because we do not know whether or not they affect the proposed reiteration effect in hindsight bias.

### Is There Evidence for an Asymmetry of Hindsight Bias (Prediction 1)?

To repeat Prediction 1: The amount of observed hindsight bias is larger for true than for false feedback assertions.

We describe in detail the design and results of one typical study and thereafter present the results of all studies used to test Prediction 1 collectively. Hertwig (1996) addressed the question of whether longer retention intervals between the original confidence and the presentation of feedback lead to greater hindsight bias. In a series of five sessions, participants responded to general knowledge assertions and stated their confidence. There was a 1-week interval between sessions, and in each session different assertions were employed—there were five different sets of feedback assertions and five different sets of no-feedback assertions. One week after the fifth session, participants received feedback (for the feedback assertions in Sessions 1–5), and 1 week after that, they were asked to recall their original confidences for the five sets of feedback assertions and the five sets of no-feedback assertions. Thus, the time interval between original confidence and recollection was systematically varied between 2 and 6 weeks. The recalled confidences of the feedback assertions in these five different intervals thus provide five tests of Prediction 1. We will return to the no-feedback assertions when testing Prediction 2. Consistent with Prediction 1, the amount of observed hindsight bias in Hertwig (1996) was larger for true than for false assertions in all five intervals (Hertwig's analysis controlled for cases of direct memory, i.e., did not include cases in which original and recalled confidence were identical).

In addition to Hertwig's (1996) study, we found eight other studies that can be used to evaluate Prediction 1. Figure 2 represents the results of all 26 tests of Prediction 1 and plots the amount of observed hindsight bias for true ( $r_t - o_t$ ) versus false ( $r_f - o_f$ ) assertions. For instance, the triangle farthest to the right represents one of Hertwig's (1996) five conditions in which observed hindsight bias was +11.8 percentage points for true assertions and –6.5 percentage points for false assertions (on a 0%–100% confidence scale). For ease of comparison, Figure 2 expresses the values for observed hindsight bias for all studies on a 0%–100% confidence scale. To take an example, Fischhoff (1977) used a probability scale of .00–1.00, and we have transformed these values by multiplying them by a factor of

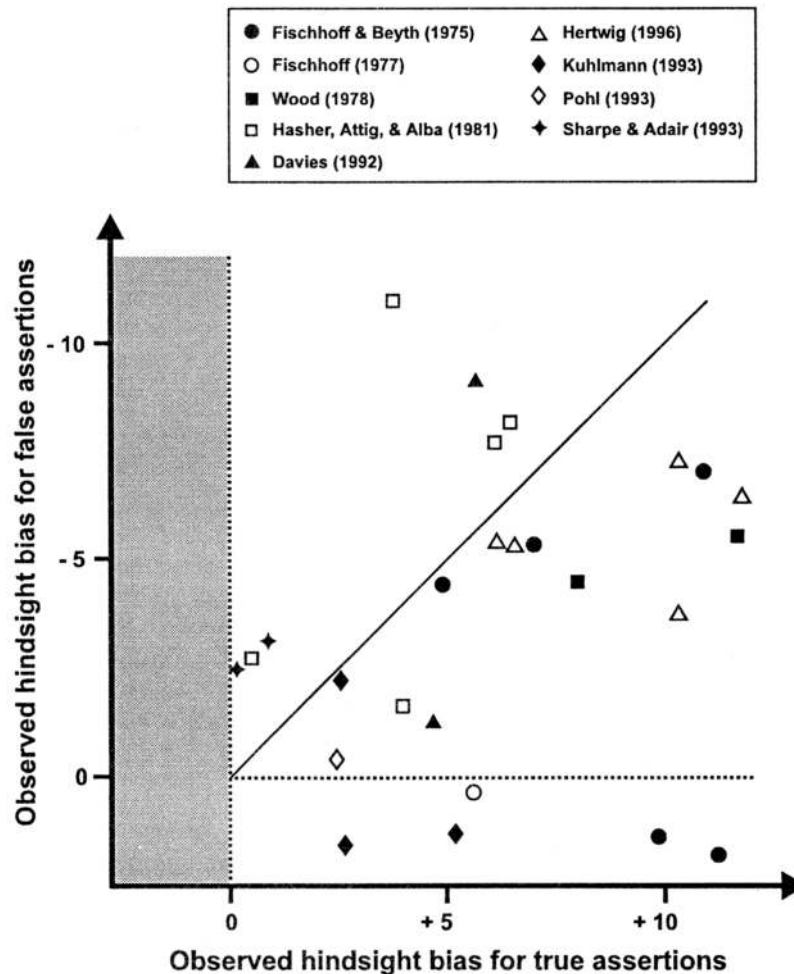


Figure 2. The amount of observed hindsight bias for true assertions ( $\alpha + \beta$ ) and false assertions ( $\alpha - \beta$ ) in 26 conditions reported in nine studies. For ease of representation, all measures of observed hindsight bias are transformed to a 0%–100% confidence scale. Values on the abscissa and ordinate measure the observed hindsight bias in terms of percentage points on this scale. Prediction 1 requires that data points lie below the diagonal.

100. Transformations of results involved simple linear scale transformation, with one exception.<sup>2</sup>

Consistent with Prediction 1, in the majority of cases—19 out of 26—the amount of observed hindsight bias is larger for true than for false assertions, and thus the data points fall below the diagonal in Figure 2. The diagonal represents equal hindsight bias for true and false assertions. Six of the seven contradictory results in Figure 2 (the data points above the diagonal) come from two sources: Hasher, Attig, and Alba (1981) and Sharpe and Adair (1993). How can we account for these deviations? There is one peculiarity in Hasher et al.'s (1981) study: True and false feedback was reversed during the first experiment. In the *disconfirmed feedback condition*, participants were told that the truth labels needed to be reversed (i.e., received the following instruction: "Oh no, did I tell you that the first ten [statements] were true? I should have said the last ten," p. 88). The result for this condition (the topmost unfilled square in Figure 2) seems to be inconsistent with Prediction 1. However, this result is in fact consistent with Prediction 1, if one assumes that

reversal of truth labels also elicits reversals of the effects of repetition and feedback. Then the recalled confidence for "false" (originally true) assertions is  $-(\alpha + \beta)$ , whereas the recalled confidence for "true" (originally false) assertions is  $-(\alpha - \beta)$ . From this it follows that the difference between recalled confidence and original confidence is larger for "false" than for "true" assertions, and thus, that the result confirms Prediction 1. However, this explanation can only account for one of the inconsistent results.

<sup>2</sup> Fischhoff and Beyth (1975) did not report differences between original and recalled confidence but reported the proportion of participants whose judgments exhibited a hindsight bias more often than not. In all five experimental groups (I–V), the proportion of participants whose judgments exhibited a hindsight bias more often than not was larger for true assertions (i.e., outcomes they believed had happened) than for false assertions (i.e., outcomes they believed had not happened). We transformed these values as follows: First, we applied Fischhoff and Beyth's (1975, pp. 6–7) analysis to the data reported by Hertwig (1996), the only study for which the necessary raw data were available.

Is there evidence for the corollary of Prediction 1 that a reversal of hindsight bias will likely occur only for false assertions and not for true assertions? If this corollary holds, then most reversals should fall below the horizontal dotted line in Figure 2 (i.e., reversal for false assertions) and not to the left of the vertical dotted line (i.e., reversal for true assertions). Reversals of hindsight bias are rare. We found five such reversals in the domain in which the reiteration effect can be produced. Although one should not make too strong a claim from such a small sample, all five reversals that occurred fall below the horizontal dotted line, consistent with the corollary of Prediction 1.

Figure 2 shows the amount of observed hindsight bias. Equations (3) and (4) allow for estimation of the size  $\beta$  of the true hindsight bias as well as the size  $\alpha$  of the reiteration effect in hindsight bias. For this estimation we use all studies reported in Figure 2. The mean size of the reiteration effect was  $\alpha = 1.2$  percentage points (on a 0%–100% confidence scale, with a range from –3.6 to 6.5); the mean size of the true hindsight bias was  $\beta = 5.0$  percentage points (with a range from 0.5 to 9.2). Thus, we have two results. First, the size of the reiteration effect in hindsight bias is small, consistent with earlier research on the reiteration effect. Second, the RH model allows us for the first time to make a direct quantitative comparison between the size  $\alpha$  of the reiteration effect in hindsight bias and the size  $\beta$  of the true hindsight bias. Our estimates suggest that  $\beta$  is roughly four times larger than  $\alpha$ . That is, the reiteration effect accounts for some 20% of the size of the observed hindsight bias for true assertions and reduces the observed hindsight bias for false assertions to some 75% of the true hindsight bias. This is of course only a first approximation.

#### *Do Knew-It-All-Along Designs Also Exhibit an Asymmetry of the Knew-It-All-Along Effect?*

Several of the studies listed above also employed a knew-it-all-along design. As stated previously, in a knew-it-all-along design assertions are presented only once, accompanied by feedback. Participants are asked to state the confidence they would have assigned to an assertion had they not received feedback.

Following their procedure, we excluded cases of direct memory (i.e.,  $r_t = o_t$ ;  $r_t = o_t$ ) and counted the number of assertions in which a hindsight bias was obtained for each participant (i.e.,  $r_t > o_t$ ;  $r_t < o_t$ ). If this number was larger than the number of cases in which  $r_t < o_t$  or  $r_t > o_t$ , then the participant was considered to be what Fischhoff and Beyth called “hypothesis-supporting” (i.e., a participant whose judgments exhibited a hindsight bias more often than not) and “nonsupporting” otherwise. From this analysis, we obtained the proportion of “hypothesis-supporting” participants in Hertwig’s (1996) study. Second, we calculated the least-squares regression of the difference between recalled and original confidence on the proportion of participants whose judgments exhibited a hindsight bias more often than not, both obtained from Hertwig (1996). The regression equation is  $y = -12.69 + .278x$ . Finally, from the regression equation, we estimated the differences between recalled and original confidence in Fischhoff and Beyth’s (1975) Groups I to V from their reported proportions of participants whose judgments exhibited a hindsight bias more often than not. This transformation is not the only one possible but it is one that preserves the asymmetry in the reported proportions of participants whose judgments exhibited a hindsight bias more often than not.

Hence, no reiteration effect should enter these hypothetical judgments. For this reason, the knew-it-all-along designs in these studies can serve as a control for Prediction 1. In contrast to the hindsight bias, no systematic asymmetry in the amount of the knew-it-all-along effect for true and false assertions follows from the RH model. Below is an examination of possible asymmetries in the knew-it-all-along designs reported in the studies reviewed above.

Fischhoff and Beyth (1975) had three knew-it-all-along conditions. In two of the conditions, more participants exhibited a knew-it-all-along effect for true than for false assertions (referring to events that the participants believed have versus have not happened), whereas in the third condition the opposite result was obtained. Fischhoff (1977) reported that in all four knew-it-all-along conditions the effect was larger for true than for false assertions, whereas Davies’ (1992) Experiment 1 and Sharpe and Adair’s (1993) Experiments 1 and 2 (Part I) yielded opposite findings. Overall, no systematic pattern of an asymmetry, such as that stated in Prediction 1, emerged from the knew-it-all-along designs.

#### *Prediction 1: Summary of the Evidence*

Fischhoff and Beyth (1975) were the first to report an asymmetry in the hindsight bias for true and false assertions. Surprised by this finding, they concluded that “the differential effect . . . was an unexpected and interesting result meriting further attention” (p. 14). The RH model explains the unexpected and interesting result as a combination of the reiteration effect and the true hindsight bias. We have reported 26 comparisons between the amount of hindsight bias observed in true versus false assertions (see Figure 2). Nineteen were consistent and 7 inconsistent with Prediction 1. As a control, we used the 10 knew-it-all-along designs in the studies reviewed. In these designs no reiteration effect occurs, and consequently, the reiteration effect cannot produce an asymmetry in the knew-it-all-along effect. In fact, the studies reviewed provide little evidence for an asymmetry in the hypothetical confidence judgments.

#### *Is There Evidence for an Increase of Confidence Without Feedback (Prediction 2)?*

To repeat Prediction 2: When no feedback about the truth or falsity of the assertions has been provided, recalled confidence is larger than original confidence.

Five of the studies used for evaluation of Prediction 1 included a total of 16 data sets that allowed for a test of Prediction 2. Not all studies reported confidences for no-feedback assertions separately for true and false assertions; therefore, in Table 1 we report the difference between recalled and original confidence averaged across true and false assertions. In 13 of these 16 data sets, the difference between recalled and original confidence was positive as predicted.

The results for no-feedback control assertions also allow for another quantitative estimate of the reiteration effect  $\alpha$ . The studies reported in Table 1 provide a mean estimate of  $\alpha = 0.7$  percentage points on a 0%–100% confidence scale. This is smaller than the estimate of 1.2 percentage points for the reiteration effect in hindsight bias (see results for Prediction 1). A smaller estimate is to be expected if the proportion of direct



Table 1  
*Test of Predicted Increase of Confidence Without Feedback*

Studies and conditions	Reiteration effect $\alpha$	Predicted increase obtained?
Fischhoff (1977), Experiment 1		
Reliability	1.20	yes
Wood (1978), Experiment 1		
No feedback	0.60	yes
Hasher, Attig, & Alba (1981), Experiment 1		
Standard feedback	-0.17	no
Disconfirmed feedback	1.33	yes
No feedback	0.33	yes
Experiment 2		
Standard feedback	1.33	yes
Disconfirmed: wrong	0.33	yes
Disconfirmed: mistake	-0.17	no
No feedback	0.33	yes
Hertwig (1996)		
2-week interval	2.20	yes
3-week interval	-0.92	no
4-week interval	0.93	yes
5-week interval	0.15	yes
6-week interval	3.10	yes
Davies (1992), Experiment 1, Consistency		
Field independent	0.61	yes
Field dependent	0.11	yes

*Note.* Positive differences represent an increase from original to recalled confidence. The estimates of the reiteration effect  $\alpha$  are averaged across true and false assertions.

memories is larger without feedback than with feedback. The rationale for this is that feedback can decrease the probability of direct recall. By averaging across assertions, one therefore gets a lower estimate for  $\alpha$  in the no-feedback condition.

What we have found is that the size of increase (Prediction 2) is generally small and, as implied by the RH model (Equation 1), is smaller than the corresponding observed hindsight bias for true assertions in each study; this can be confirmed by comparing values in Figure 2 and Table 1.

### Discussion

Why is observed hindsight bias larger for true than for false assertions? In this article, we have proposed a solution for this puzzling result, which has been reported as a fairly stable phenomenon in hindsight bias studies since Fischhoff and Beyth (1975). We have argued that repetition of assertions increases the confidence in the assertions' truth. This reiteration effect in turn produces a larger observed hindsight bias for true than for false assertions.

Why does average confidence increase slightly in hindsight bias studies despite the absence of positive feedback? The RH model implies that this increase is because repetition enhances confidence. The evidence reviewed supports, with some exceptions, both predictions.

### Alternative Accounts

What contrasting accounts of these phenomena have been proposed in the literature? There have been several attempts to

explain the asymmetry in hindsight bias (Christensen-Szalan-ski & Fobian Willham, 1991; Fischhoff, 1977; see also Connolly & Bukszar, 1990). None of these suggestions have resulted in a precise model. To the best of our knowledge, the RH model is the first theoretical account to explain the asymmetry in hindsight bias. In addition, it predicts the increase in confidence in the absence of feedback.

We can think of two alternative explanations for an asymmetry in observed hindsight bias (Prediction 1).

*Better memory of confidences in false assertions.* The first alternative explanation is based on the possibility of differential direct memory of confidences for true and false assertions. If the confidences in false assertions were more often recalled directly (as opposed to being reconstructed), then the proportion of assertions showing a hindsight bias would be lower for false assertions. This differential direct memory implies that the averaged observed hindsight bias would be smaller for false than for true assertions. This explanation can be checked by using the number of veridical recollections as an estimate of cases of direct memory. We know of two studies that have reported these data. In Hertwig (1996), the number of veridical recollections was smaller for false assertions, in contrast to this alternative explanation. In Pohl (1993), the number of veridical recollections was nearly identical for true and false assertions. Thus, these studies show no evidence of a better memory for confidences in false assertions.

*Anchoring and adjustment heuristic.* Fischhoff (1977, p. 354) noted that the "intriguing" asymmetry in observed hindsight bias for true and false assertions contradicted his earlier explanation of the hindsight bias using Tversky and Kahneman's (1974) anchoring and adjustment heuristic. The explanation was that individuals anchor their confidence in the feedback (i.e., .00 for "false" and 1.00 for "true") and adjust it from there: "This explanation fails, however, to account for . . . why it should be easier to adjust upward from .00 than downward from 1.00" (Fischhoff, 1977, p. 357). Fischhoff (1977) correctly argued that the anchoring and adjustment heuristic by itself cannot account for an asymmetry in hindsight bias.

Let us, however, add the common observation that the original confidence tends to be slightly above the scale's midpoint (Wallsten & González-Vallejo, 1994). In that case, the heuristic would produce an asymmetry because recalled confidence ( $r_t$  or  $r_f$ ) results from equally sized adjustments with either a 0% or 100% confidence serving as an anchor. From original confidence ( $o_t$  or  $o_f$ ) > 50% follows that the absolute size  $|r_t - o_t|$  of the hindsight bias for false assertions is larger than the absolute size  $|r_t - o_t|$  of the hindsight bias for true assertions. Therefore, combined with the empirical fact that original confidence tends to be above the scale's midpoint, the anchoring and adjustment heuristic in fact can predict an asymmetry in hindsight bias. However, the predicted asymmetry is in the opposite direction from that of the RH model and is inconsistent with the data reviewed.

### Quantitative Estimates

The reiteration effect was estimated by assuming a simple, additive combination of  $\alpha$  and  $\beta$  (see Equations 3 and 4). There are, however, alternative ways of modeling how the two effects combine. Further research may succeed in finding a more direct way to estimate the amount of the reiteration effect in hindsight bias.

Regardless of how the two effects combine, one might propose that the size of  $\alpha$  in hindsight bias studies can be estimated from results reported in reiteration effect studies. We argue, however, that this would lead to an overestimate of the magnitude of  $\alpha$  and that the no-feedback control assertions in the hindsight design may yield a more precise estimate. The reason for overestimation is that the task in a hindsight design, unlike in a reiteration design, is by instruction a memory task. The frequency of judgments that are cases of direct memories should therefore be expected to be higher in hindsight bias studies. Cases of direct memories exclude the reiteration effect by definition. If, due to memory instruction, there are more cases of direct memory in a hindsight design than in the reiteration design, it then follows that the average reiteration effect observed in a hindsight design should be smaller than the corresponding average effect observed in a reiteration design. Because the tasks for feedback assertions and no-feedback control assertions in a hindsight design are the same—a memory task—the increase of confidence in the no-feedback control assertions (see Prediction 2) in the hindsight design (rather than in the reiteration design) seems to be a more appropriate estimate for the size of the reiteration effect in hindsight bias.

The results for the no-feedback control assertions suggest that the increase in confidence is indeed small (see Table 1). Calculation of Cohen's (1988, pp. 48–49, formula 2.3.8)  $d$  gives an estimate for the effect size of the increase ( $\alpha$ ). Effect size  $d$  is the difference between two means (such as the means of original and recalled confidences), divided by the pooled standard deviation (pooled because of unequal variances, Cohen, 1988, pp. 44–45). The data necessary for calculating effect sizes were only reported in Hasher et al. (1981) and Hertwig (1996). The reiteration effect in each study (averaged across conditions,  $d = .05$  in Hasher et al., and  $d = .07$  in Hertwig) was below .20, which is "small" in Cohen's (1988) classification.

### *Hindsight Bias $\neq$ Knew-It-All-Along Effect*

Hindsight bias and the knew-it-all-along effect are often treated as the same phenomenon; in fact, these terms have sometimes been used interchangeably. The RH model of the reiteration effect in hindsight bias, however, provides a theoretical reason why observed hindsight bias is not the same as the knew-it-all-along effect. Through the repetition of assertions, observed hindsight bias includes a reiteration effect, whereas the knew-it-all-along effect does not. Consequently, observed hindsight bias is asymmetric, but the knew-it-all-along effect is not.

Furthermore, hindsight bias and the knew-it-all-along effect differ with respect to direct memories. Cases of direct memories for original confidence may account for the frequent observation that the average knew-it-all-along effect is larger than the average observed hindsight bias (e.g., Davies, 1992; Fischhoff, 1977; Sharpe & Adair, 1993). Unlike in the knew-it-all-along design, the task in the hindsight design is one of memory, and therefore, cases of direct memories will decrease the number of assertions where the hindsight bias can become manifest. Even if the two effects would otherwise be of the same size, averaging over all instances (including cases of direct memory) would lead to an observed average hindsight bias smaller than the average knew-it-all-along effect.

### *Generalization of the RH Model*

We propose one generalization of the RH model: It is from the recollection of confidence to the recollection of feedback. Studies on hindsight bias have focused on memory of original confidence, whereas memory of feedback has so far received little attention. The RH model predicts an asymmetry in correct recollections of feedback for true versus false assertions.

In those cases where there is no direct memory of feedback, the feedback needs to be reconstructed, just as does the original confidence. For the recollection of original confidence, feedback is assumed to influence recalled confidence. For the recollection of feedback, confidence is assumed to be used to infer the feedback. At the moment when participants are again presented with the assertion and asked "What was the feedback?" the reiteration effect increases confidence in the truth of this assertion. The increased confidence leads with a higher probability to the inference that the feedback was "true" if it was actually true than to the inference that the feedback was "false" if it was false. From this it follows that for repeated assertions,

$$\text{error rate ("false" | true)} < \text{error rate ("true" | false)},$$

where error rate ("false" | true) is the proportion of recollections of "false" feedback when the feedback was actually true. Thus, if one asks participants which of the assertions are actually true (assuming that they do not question the validity of the feedback), more false assertions will be classified as true than true assertions will be classified as false.

We have not found a single hindsight bias study (that used assertions) that investigated the recollection of feedback. We have found one study that asked participants to recall feedback for repeated assertions without addressing the issue of hindsight bias. Gilbert, Tafarodi, and Malone (1993) investigated whether understanding and believing are two separate and sequential psychological processes. In both experiments, participants read assertions about criminal incidents (e.g., "The robber had a gun") that were marked as either true or false. Half of the participants worked in an interrupted condition and the other half in an uninterrupted condition. Thereafter, the assertions were repeated (mixed with new assertions), and the participants' task was, among others, to classify each assertion as either true, false, or new.

Because true and false assertions were repeated at the time of classification, a reiteration effect should occur. That is, the proportion of assertions incorrectly classified as true should be larger than the proportion incorrectly classified as false. Gilbert et al. (1993) reported six conditions (Tables 2, 4, and 5) that allowed for six tests of this prediction. Each of the six results showed the predicted asymmetry. The average proportion of true assertions classified as false was .04, whereas the average proportion of false assertions classified as true was .37. The authors explained these consistent effects by Spinoza's thesis that understanding means believing (in their experiments understanding meant uninterrupted reading). The RH model can integrate this finding of an asymmetry in correct recollections of feedback into the class of phenomena involving the reiteration effect.

### *Toward a Theoretical Integration of Research on Confidence Judgments*

Research on confidence in the last three decades has generated several striking phenomena including hindsight bias, the knew-it-all-



along effect, conservatism, overconfidence bias, the hard-easy effect, and the reiteration effect, yet we know very little about the relationship between them. One exception is the work by Erev, Wallsten, and Budescu (1994), which demonstrates that both overconfidence and conservatism can be obtained from true judgments distorted by random error, depending on the kind of data aggregation used. This work emphasizes the way the data are aggregated but it does not model the mechanism underlying confidence. Gigerenzer et al. (1991) and Gigerenzer (1993) have provided a theory and experimental evidence for an integrative explanation of the overconfidence bias, the hard-easy effect, and the conditions under which both disappear or invert. We regard the RH model as a further step toward a theoretical integration of findings in human confidence.

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Received March 8, 1994

Revision received June 17, 1996

Accepted June 25, 1996 ■