Misinformed and Biased: Genuine Memory Distortions or Artifactual Phenomena?

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Abstract

In the present study, two cognitive phenomena until now treated apart were compared to each other: *hindsight bias* and *misinformation effect*. Both phenomena result from the same basic retroactive-interference procedure focussing on how memory of originally encoded material is distorted by the encoding of subsequent, conflicting information. The results showed that subjects' recollections of the original information were similarly distorted under both conditions, that is, the amount of hindsight bias was as large as the misinformation effect. More fine-grained analyses, however, revealed important differences. With the additional results of a probability mixture model it was found that only hindsight subjects suffered from memory impairment and that, moreover, their recollections included genuine blends. The misinformation effect, on the other hand, turned out to be an artifact of averaging across two different sets of recollections. These results represent compelling data with respect to the ongoing discussion about the existence of genuine memory blends.

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Introduction

Since the early times of pro- and retro-active inhibition it has been shown repeatedly that two pieces of information tied to the same memory node may interfere with one another, thus leading to an impaired memory performance. More recently, two paradigms have studied these interference processes at some length: The *hindsight-bias* paradigm (see, e.g., Christensen-Szalanski & Fobian Willham, 1991; Hawkins & Hastie, 1990) and the *eyewitness-misinformation* paradigm (see, e.g., Loftus, Korf, & Schooler, 1989). In both areas, researchers found that presentation of "new", conflicting information can distort memory for "old", original information.

Hindsight bias. A typical hindsight-bias experiment proceeds in the following way: First, subjects are asked to answer difficult almanac-type questions, for example: "How high is the Statue of Liberty?" Later they receive the solution and finally they are asked to remember their original answers. Typically the recollections lie closer to the solution than the original answers did (see, e.g., Hell et al., 1988; Pohl, 1990). This effect has been referred to as "hindsight bias" or "knew-it-all-along" effect (Fischhoff, 1977; Wood, 1978). The hindsight bias seems to be independent from a variety of experimental manipulations and has, moreover,

been observed for rather different materials (see Hawkins & Hastie, 1990, for a recent overview).

Most theoretical explanations favor the final rejudgment process as the point where biasing occurs. According to these, the hindsight bias is a necessary and unavoidable by-product of collecting evidence in the judgment process. The automatic memory distortion comes about because during the rejudgment process subjects are apparently unable to ignore outcome knowledge (cf. Tversky & Kahneman, 1974).

Misinformation effect. In eyewitness-misinformation studies, subjects typically view a sequence of slides depicting some complex event (e.g., a car accident). In a following questionnaire, the experimenter hides information contradictory to some of the details in the slides. For example, a stop sign in the slides is now labeled as a yield sign. Finally, in the test phase, subjects are asked to choose the original information (as seen in the slides) from a pair of two alternatives. In the above example these alternatives would include the stop sign and the yield sign. Subjects who were misled in the questionnaire typically tend to choose the correct alternative less often than subjects who were not misled (see, e.g., Loftus, Miller, & Burns, 1978). This result has been labeled "misinformation effect".

The effect was found over a variety of materials (see Loftus et al., 1989) and has resisted a number of experimental manipulations that were devised to eliminate it (summarized in Loftus, 1979). Accordingly, Loftus strongly argued for automatic updating processes suggesting that misinformation erased the memory representation of original information rendering it irretrievable. This argument is known as the "substitution hypothesis". But later research showed that both original and misinformation may coexist in memory (see, e.g., Bekerian & Bowers, 1983). The misinformation effect then can be understood as being caused by differences in retrievability (Christiaansen & Ochalek, 1983; Morton, Hammersley, & Bekerian, 1985). McCloskey and Zaragoza (1985), though, challenged both views (substitution and coexistence) and criticized the misinformation effect as an artifact of the testing procedure used. In their opinion, the misinformation effect does not result from memory impairment, but arises because different memory and guessing states are unjustly summed across.

The theoretical interpretation of the misinformation effect is still a matter of debate (Chandler, 1991; Metcalfe & Bjork, 1991; Schooler & Tanaka, 1991). Besides the introduction of different new testing procedures, a more promising approach has focussed on the use of material with continuous features (instead of whole objects). Results of these experiments typically showed some form of "memory blends" (Chandler, 1991; Loftus, 1977) paralleling the typical results found in hindsight-bias studies.

Memory blends. Memory distortion is understood (in this paper) as a general term denoting that in some way memory was affected by an experimental condition. Memory blends are recollections that show integration of features from different items. Following Schooler and Tanaka (1991) it appears useful to further distinguish between "representation blends" (that result from encoding or storage processes) and "recollection blends" (that emerge from retrieval processes). While these two types refer to the point where blending occurs, a further distinction denotes the content of blending: A "composite blend" integrates separable objects from different sources, for example, adding a stop sign (from a verbal description) to a traffic scene (from a slide sequence; Loftus, Miller, & Burns, 1978). A "compromise blend", on the other hand, integrates different feature values into one value (by some sort of averaging process), for example, an originally blue car, which was later referred to as being green, is remembered

as a bluish green one (Loftus, 1977). Similarly, Metcalfe and Bjork (1991, p. 203) defined a "positive blend" (Metcalfe, 1990) as one where "subjects' recollections of the original event must show a unimodal shift along some dimension in the direction of the misleading event."

But still, the critique of McCloskey and Zaragoza (1985) applies. Metcalfe and Bjork (1991) referred to this situation in their "summed distribution hypothesis": If one type of recollection was centered around the original information, the other one around the misinformation, and if both original and misinformation were not too far apart from each other on their underlying dimension, then the summed recollections may show a unimodal distribution. The mean recollection would then mimick a typical misinformation effect (or hindsight bias) despite the absence of any genuine (memory or recollection) blends.

Summarizing this discussion, it again seems urgent to separate genuine blends from statistical averaging "effects". To this end, a probability mixture model was devised that is described next.

Probability mixture model. (Because of space constraints, only a general outline will be given here; cf. Pohl & Gawlik, 1992.) The model assumes as latent states two knowledge-retrieval cases for control items and five cases for experimental items. Each case is considered to be true for an unknown proportion of all recollections and is associated with different probabilities that a recollection falls within one out of five recollection classes. The latent states reflect which information is available to the subject at the time of retrieval. The recollection classes are defined as follows: (1) recollections shifted away from the solution/misinformation, (2) perfect recollections, (3) recollections shifted towards the solution/misinformation, (4) erroneous recall of the solution/misinformation itself, and (5) recollections shifted beyond the solution/misinformation.

The model was varied according to two major questions. First, the percentage of perfect recollections was either allowed to differ between control and experimental items or not. (For *experimental* items, the solution/misinformation was provided to the subject, while for *control* items, this was not the case.) The McCloskey and Zaragoza (1985) argument stated that—despite the presence of a misinformation effect—the percentages of correctly known (not guessed) recollections could be equal for both types of items. In that case no *memory impairment* occurred. This can be tested by comparing the fits of the corresponding model versions.

Second and more important, the case of *positive blends* was either included in the model or not. Again, the presence or absence of such blends can be concluded from the resulting model fits. It should be noted that both questions (memory impairment and positive blends) can each be accessed independently from one another.

Method

Subjects. 40 students of the University of Trier were randomly assigned to the *hindsight* group or to the *misinformation* group.

Material. A catalogue of 20 objects to-be-sold at a fictitious auction at Sothebys was prepared. Each page of the catalogue contained the picture of one of the objects together with a short description of it. Each object contained one critical (numerical) information. The auction catalogue was prepared in two versions. In the hindsight version, the values of the critical information were replaced by an empty box with a question mark. In the misinformation version, all values were filled in and not marked as critical in any way.

Procedure. Each subject was run individually in two sessions one week apart. The hindsight sub-

jects were run first in order to allow matching of the misinformation subjects. In Session 1, all subjects received the auction catalogue. Each hindsight subject was given the hindsight version and asked to estimate the left-out values. Each misinformation subject was given the misinformation version (with the estimates of a hindsight subject filled in as original information) and instructed to read all descriptions carefully. In Session 2, all subjects first received a feedback list (with solutions/misinformations to some of the items). Then, all subjects again received the auction catalogue, now all in the hindsight version. Subjects of the hindsight group were asked to remember their estimates given in the first session. Misinformation subjects were asked to remember the original information from the first presentation of the catalogue.

Results

The level of significance was set at $\alpha = .05$ for all statistical analyses.

Shift in recollections. In order to allow comparison across numerically dissonant items, all data were z-transformed separately for each item. Then, the absolute z-score distances between original estimate/information and solution/misinformation (i.e., the *original distance*) and between recollection and solution/misinformation (i.e., the *recollection distance*) were computed. For experimental items, the mean changes from original distances to recollection distances reached -.41 z and -.34 z for hindsight and misinformation subjects, respectively. The corresponding figures for control items were .07 z and .12 z. The analyses of variance revealed one effect: With experimental items, recollection distances were significantly shorter than original distances ($F(1,9) = 14.42$) implying that on an average recollections were closer to the solution/misinformation than the original estimate/information had been. But with control items, the distance did not change remarkably ($F(1,9) = 2.91$, $\alpha > .10$). The group variable (hindsight vs. misinformation) produced neither main nor interaction effects (all $F < 1$).

Perfect recollections. In the hindsight group, the proportion of perfect recollections reached 33% with control items and dropped to 11% with experimental ones ($\chi^2(1) = 11.56$). The misinformation group produced 11% perfect recollections with control items and 8% with experimental ones ($\chi^2(1) < 1$).

Model fitting. The numbers of recollections for each of the five recollection classes were submitted to the model fit. A least-squares iteration procedure was run separately for the hindsight and for the misinformation group with all four versions of the probability mixture model (as described in the Introduction). The results are presented in Table 1. For the hindsight group, the four versions produced model fits of clearly diverging quality, suggesting that both memory impairment and positive blending occurred. For the misinformation group, though, all versions of the model fitted the data equally well, suggesting that neither memory impairment nor positive blending occurred.

Discussion

At first glance, the results seemed to be clear and simple. When looking at the *mean shift of recollections* as compared to original estimate/information, both hindsight and misinformation group showed the same effect: While there was no memory distortion with control items, both groups revealed an equal amount of memory distortion with experimental items, that is, the hindsight bias was as large as the misinformation effect. The further, more fine-grained analysis, though, proved this conclusion to be premature.

Table 1.
Best Fits (χ^2) of the Four Versions of the Probability Mixture Model for Hindsight and Misinformation Subjects

Model version		*df*	Hindsight	Misinformation
Without memory impairment.				
Without blends	(1)	4	18.39 *	1.36 +
With blends	(2)	3	12.78 *	1.03 +
With memory impairment				
Without blends	(3)	3	4.77	.69 +
With blends	(4)	2	.14 +	.39 +

* $\alpha < .01$, + $\alpha > .70$.

First of all, consider the *percentages of perfect recollections*. The percentages of perfect recollections of experimental items (as compared to control items) was severely diminished in the hindsight group, but not in the misinformation group. Following the argument of McCloskey and Zaragoza (1985), this observation implies that only the memory of hindsight subjects was impaired by the items' solutions, while the memory of misinformation subjects was unaffected by the misinformation.

Fitting the four versions of our *probability mixture model* to the data revealed quite different results for the two groups. In the hindsight group, the model fitted the data perfectly only when two parameters were used to account for memory impairment and positive blends. In the misinformation group, though, all versions produced the same good fit of the model. This, once more, suggests that only hindsight subjects suffered from memory impairment and that they, moreover, produced a significant number of bias recollections (positive blends), while misinformation subjects apparently produced none.

In the light of these observations, the conclusion drawn earlier receives strong support: Only the recollections of hindsight-subjects include cases of genuine positive blends, while the misinformation effect appears as an artifact of statistical averaging. This interpretation corroborates the considerations of McCloskey and Zaragoza (1985) and dismisses their opponents' attempt to rescue the misinformation effect as a memory phenomenon (Loftus, Schooler, & Wagenaar, 1985). The use of experimental material with continuous features (instead of whole objects) and recall as test method (instead of recognition) proved to be a sensible way to detect the suspected artifact.

Now that no cognitive account seems to be necessary for the misinformation effect, what remains to be explained is how the *hindsight bias* arose. If the subject knew roughly both sources of information, that is, she remembered the numerical region of her estimate and the relation between it and the solution, she was hampered by knowing the solution when she tried to reconstruct her estimate. As a consequence, recollections of this sort should fall between estimate and solution reflecting the genuine hindsight-bias case. This situation was described by Tversky and Kahneman (1974) as one of their heuristics named "anchoring and adjustment", where the anchor prevents full adjustment.

With respect to past as well as future research on hindsight bias, misinformation effect, or similar phenomena, recollection data should be

analyzed more carefully. The proposed probability mixture model—or generally, any multinomial model (Riefer & Batchelder, 1988)—should be able to detect statistical "effects" of the McCloskey-Zaragoza type, thereby avoiding artifactual explanations.

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