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Recognition performance level and the magnitude of the misinformation effect in eyewitness memory

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The issue of whether misleading postevent information affects performance on the modified recognition test introduced by McCloskey and Zaragoza (1985) was examined in a meta-analysis. Results indicated that a misinformation effect can be obtained with the modified test. The meta-analysis also revealed that recognition hit rates are higher in studies that yield a misinformation effect than in studies in which the misinformation effect is not significant. The data from the meta-analysis were also used to assess whether the misinformation effect is related to the length of the retention interval. Results showed that a misinformation effect is more likely to be obtained with long retention intervals, although in the available data there is a confound between the length of the retention interval and the recognition level obtained.

Eyewitness memory researchers have long been interested in whether providing subjects with misleading information after they have viewed an event will affect their ability to report the details of the original event. Seminal work by Elizabeth Loftus and her colleagues in the 1970s (e.g., Loftus, 1978; Loftus, Miller, & Burns, 1978) indicated that misleading postevent information can result in a significant drop in subjects' recognition accuracy. In a typical experiment from these studies, subjects view an event such as a traffic accident. After this, they are given either misleading or neutral information concerning details of the original event. For example, if a stop sign appeared in the original event, the misleading postevent information might refer to a yield sign, but in the control condition the postevent information could refer to a traffic sign. Finally, the subjects are given a forced-choice recognition test, in which the alternatives are the original item and the item referred to in the misleading postevent information (in this example, a stop sign vs. a yield sign). A consistent finding from these studies is that subjects are less accurate at recognizing the original item in the "misled" condition than in the control condition.

Loftus and her colleagues have argued that these data indicate that the misleading information has either "overwritten" or replaced the original information in the representation of the event (e.g., Loftus, 1979; Loftus & Loftus, 1980; Loftus et al., 1978). This "overwriting" hypothesis attributes the misleading-information effect to memory impairment. *Memory impairment* is used here to refer to either a decrease in the accessibility of the original memory trace or an alteration, or overwriting, of the original trace. Although memory impairment was the dominant theoretical view in the 1970s and early 1980s, in more recent times investigators have come to question the view that misleading information alters the memory of the original event.

Much of the recent controversy concerning memory impairment stems from McCloskey and Zaragoza (1985), who introduced the modified recognition test as a sensitive method for detecting memory impairment. In McCloskey and Zaragoza's study, subjects viewed a series of slides depicting an incident in which a maintenance man entered an office and repaired a chair. One of the critical items in the slide sequence was the tool used by the maintenance man. For different groups of subjects, this tool was a hammer, a wrench, or a screwdriver. If the subjects viewed, say, the hammer in the slides, then the misleading information presented afterward might refer to the tool as a screwdriver. In the control condition, they were given neutral information concerning critical items (e.g., the postevent information could refer to a tool).

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The modified recognition test introduced by McCloskey and Zaragoza (1985) is a two-alternative forced-choice test, in which the test alternatives are the original item (e.g., hammer in the present example) and a new item (e.g., wrench) that was not presented either in the original episode or during the retention interval. If misleading postevent information changes either the accessibility or the contents of the original memory trace, subjects' recognition performance should be worse for items that they were misled about than for control items for which they received either neutral or no postevent information. In six experiments with the modified test, McCloskey and Zaragoza found no significant difference in correct recognition rates for "misled" and control items.[1] On the basis of these findings, McCloskey and Zaragoza (1985) argued that there was no empirical evidence of memory impairment—a view that they reiterated several years later (Zaragoza & McCloskey, 1989). There are, however, a number of studies that have obtained a misinformation effect when the modified recognition test was used (e.g., Chandler, 1989; Ceci, Ross, & Toglia, 1987), and there has been considerable controversy in the literature concerning the necessary and sufficient conditions for obtaining a misinformation effect with the modified recognition test.

This paper has three goals that are related to the memory impairment issue. First, we asked whether the extant data are consistent with McCloskey and Zaragoza's (1985) conclusion that there is no evidence of memory impairment resulting from misleading postevent information when the modified test is employed. To address this question, we conducted a meta-analysis by using data from a large number of studies. Second, we sought to test the hypothesis that detecting a misinformation effect (i.e., worse performance for the misled items than for the control items on the modified test) requires that recognition performance be relatively high. This hypothesis arises from an examination of the data base from studies with the modified test (discussed further below) and also from the suggestions of Toglia (1991) and Chandler (1989). Toglia and Chandler have both argued that in order to detect a misinformation effect, it is important that performance levels be reasonably high. Finally, we asked whether obtaining the misinformation effect with the modified recognition test depends upon the use of long retention intervals, a view that has been suggested recently by Belli, Windschitl, McCarthy, and Winfrey (1992).

We (Toglia, 1991; Toglia, Payne, & Anastasi, 1991) were first drawn to the idea that recognition performance levels may play a role in producing the misinformation effect when we examined McCloskey and Zaragoza's (1985) data. Their data revealed that there was a sizable correlation ($r = .69$) between the level of recognition performance on control items and the magnitude of the misinformation effect, as measured by the difference between the hit rate for the control items and the hit rate for the misled items. This correlation indicates that, as control performance levels were raised, the magnitude of the misinformation effect was also increased. There are at least two possible explanations for this correlation. First, to detect a misinformation effect, it may be necessary to obtain relatively high performance levels. One reason for the plausibility of this performance-level hypothesis is that, due to the use of a two-alternative forced-choice recognition test, the magnitude of any effect of misleading postevent information will be reduced by 50%. This is due to subjects' guessing the correct item even if their memory for the item has been impaired (see Chandler, 1989, for a more detailed account of this reduction in effect size). The hypothesis also seems reasonable when one considers the possible impact of postevent information as a function of subjects' memory for the original information. If subjects' memory for the original information is quite poor—close to 50% on the modified test—then there is little possibility for producing memory impairment. Similarly, when subjects' memory for the original episode is quite good (i.e., near perfect performance on the modified test), then it is unlikely that postevent information would yield a misinformation effect. It is only when memory is neither extremely poor nor extremely accurate that a misinformation effect is likely to be obtained.

A second possible explanation for the correlation between performance levels and the misinformation effect is that it may simply reflect sampling error. To appreciate how sampling error could lead to a correlation between performance levels and the misinformation effect, imagine that we repeat the same experiment many times, but with slightly different procedures and different samples of subjects. Assume for the moment that the procedural differences across experiments exert no effect on recognition accuracy levels. If we also assume that misinformation really has no effect on recognition accuracy, then performance in each experiment should be equivalent for the control and misled items. In other words, the population means for the control and misled conditions are identical. However, since there is measurement and/or sampling error in each of these experiments, there will be some variability in the observed recognition levels for both the control and misled items across experiments. For any given experiment, then, if the recognition level observed in the control condition is much higher than the population mean, and if the recognition level for the misled condition is closer to the expected value (i.e., the population mean), then this will suggest that there is a misinformation effect. Note that this conclusion will arise even though there is no difference between the population means for the control and misled conditions. In addition, the farther the sample mean for the control condition moves above the population mean, the larger the difference between the misled and control conditions. This state of affairs would suggest that, as performance levels in the control condition are raised, so is the magnitude of the difference in performance levels between the control and misled conditions. Note that a corollary of this analysis is that there should be a symmetrical relationship between performance levels in the control condition and the magnitude of the misinformation effect. When (due to sampling error) performance levels in the control condition are very high, the misinformation effect (defined as control performance minus misled performance) will be large and positive; when (again, due to sampling error) performance levels in the control condition are very low, the misinformation effect will be large and negative.[2]

Recognition Levels and the Misinformation Effect: A Meta-Analysis

One way to test the hypothesis that there is a relation between performance levels on the control items and the magnitude of the misinformation effect is to examine the results of published studies in which the modified recognition test was used. If we assume that the recognition levels obtained across experiments reflect the specific combinations of subjects, materials, methods, and so on employed in these studies, then this meta-analytic approach allows us to test the first explanation. If a misinformation effect is dependent upon recognition levels, then (barring possible ceiling effects) there should be a positive correlation between recognition level and the magnitude of the misinformation effect. The meta-analytic approach also allows us to test the sampling error interpretation: If sampling error alone is responsible for the correlation between performance level and the misinformation effect, then any sampling error that occurs across studies should occur equally often for the control and misled items. The sampling error view thus predicts that there should be symmetry in the data, and that some studies will show better performance for the control items than for the misled items, and other studies will show better recognition rates for the misled items than for the control items.

We surveyed the literature and found 48 cases from 13 journal articles or book chapters, each of which included (1) an initial study phase, (2) an interpolated phase in which misleading information was presented, and (3) a modified recognition test. Four of these cases were excluded due to ceiling effects (i.e., performance for both control and misled groups exceeded 94%) that precluded detecting a misinformation effect. Table 1 lists the sources for these cases and also presents the two data points (control, misled) for all 48 cases. Table 1 also indicates whether the study involved a short (1 h or less) or long (24 h or more) retention interval; we will discuss this further below.

Using the data from the 44 cases that were not at ceiling, we asked several straightforward questions. First, is there any evidence of a memory impairment effect? Generally speaking, based on the statistical results reported in the original studies, the answer to this question appears to be "no." In the original reports from which these data points were drawn, 30 of the cases showed no statistically significant misleading effect, and only 14 cases showed a significant effect. However, when we consider all 44 cases together, we are led to a different conclusion: Across all cases, mean recognition level in the misled condition was significantly lower than that in the control condition [71.7% vs. 75.8%; $t(43) = 4.65$, $p < .001$]. This difference was also significant by a sign test ($p < .05$); out of 40 nontied cases, 30 showed a misinformation effect. Thus, although the misinformation effect does not appear robust within individual studies, the aggregate data indicate that the effect is significant.

The second question we asked was whether the misinformation effect is related to performance levels. We addressed this question by asking whether the correlation between performance in the control condition and the magnitude of the effect size (defined as the difference in recognition rates for the control and misled items), which was suggested in McCloskey and Zaragoza's (1985) study, was also evidenced in the 44 cases drawn from the literature. Figure 1 presents a scatterplot of the recognition rates in the control condition and the magnitude of the effect size for these 44 cases. Analysis of these data revealed a significant correlation ($r = .54$, $p < .001$) between performance in the control condition and the magnitude of the effect size.

We also compared the recognition rate (as indexed by performance on the control items) from the studies that reported a significant misinformation effect with rates from the studies in which the effect was not significant (see Table 1). The results of this analysis indicated that hit rates in the control condition were higher for those cases in which there was a significant misinformation effect than it was in the studies reporting a nonsignificant misinformation effect [81.1% vs. 73.6%; $t(42) = 3.40$, $p < .001$]. Taken together, these two findings provide reasonably strong support for the conclusion that the misinformation effect is related to performance levels.

Recognition Level versus Retention Interval

Belli et al. (1992) recently reported four experiments that suggested that, when using the modified recognition

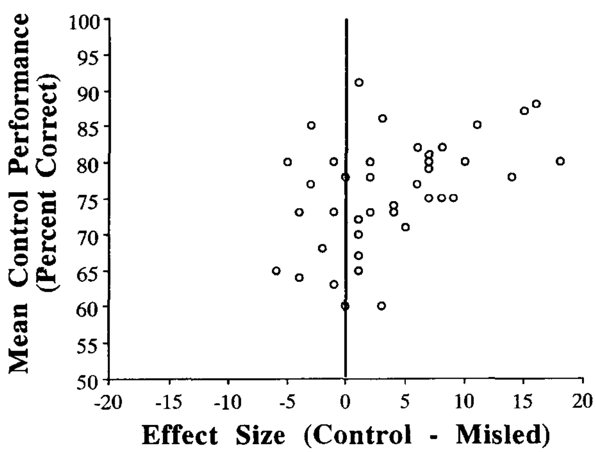

Figure 1. Scatterplots of performance level for the control items and the size of the misinformation effect for the 44 cases drawn from the literature.

Table 1
Meta-Analysis Data for Significant and Nonsignificant Comparisons

Author	Year	Retention Interval	Control	Modified	Effect
Studies That Show a Significant Postevent Misinformation Effect					
Belli, Windschitl, McCarthy, & Winfrey	1992	long	75	67	8
		long	80	70	10
Ceci, Ross, & Toglia	1987	long	87	71	16
		long	88	72	16
Chandler	1989	short	80	73	7
		short	79	72	7
Chandler	1991	short	85	74	11
		short	81	74	7
		short	80	73	7
		short	82	74	8
		short	81	76	5
Toglia, Ross, Ceci, & Hembrooke	1992	long	80	68	12
		long	77	60	17
		long	80	62	18
Studies That Do Not Show a Significant Postevent Misinformation Effect					
Belli	1993	short	72	71	1
		short	74	70	4
		short	67	66	1
		short	65	71	−6
Belli, Windschitl, McCarthy, & Winfrey	1992	short	94	94	0*
		short	80	85	−5
Bonto & Payne	1991	short	60	60	0
		short	60	57	3
Bowman & Zaragoza	1989	short	75	68	7
		short	91	90	1
Ceci, Ross, & Toglia	1987	long	>95	>95	0*
Chandler	1989	short	65	64	1
		short	68	70	−2
Chandler	1991	long	80	81	−1
		long	80	78	2
		long	78	78	0
		long	78	76	2
Loftus, Donders, Hoffman, & Schooler	1989	short	64	68	−4
		short	63	64	−1
McCloskey & Zaragoza	1985	short	71	66	5
		short	77	71	6
		short	73	77	−4
		short	81	74	7
		short	68	70	−2
		short	77	71	6
Zaragoza	1987	short	70	69	1
		short	73	74	−1
Zaragoza	1991	short	73	71	2
		short	97	94	3*
		short	82	76	6
		short	98	96	2*
		long	73	69	4
Zaragoza, Dahlgren, & Muench	1992	long	86	83	3
		long	77	80	−3

test, a misinformation effect is more likely to be obtained with long retention intervals than with short retention intervals. At first glance, these data appear to be at odds with the conclusion we are drawing from the meta-analysis, since one would assume that performance levels would be higher with short retention intervals than with long intervals. There are, however, three reasons for questioning the validity of this assumption with respect to retention interval and performance levels. First, there are very few studies with data from both short and long retention intervals; when Belli et al. examined the data available in 1992, *all* of their comparisons of retention interval were across-study comparisons. Second, for the studies that do include data from both short and long retention intervals, there are confounds between the retention interval and other factors. For example, in the three experiments reported by Belli et al. (1992) that were not plagued by a ceiling effect problem (Experiments 2–4), the presentation conditions and the retention interval were necessarily confounded. Due to the forgetting that takes place over the retention interval, it was necessary for Belli et al. to use different encoding conditions for the conditions with short and long retention intervals. For the long-interval conditions in Belli et al.'s study, the target items appeared in slides that were presented at a rate of 5 sec per slide; for the short-interval condition, the exposure time per slide was 0.3 sec. This nearly 20-fold difference in encoding time could easily have produced major differences in what the subjects extracted from the slides, thus making it difficult to unambiguously attribute differences across the short- and long-interval conditions solely to the length of the retention interval.

The third problem with the conclusion that finding a misinformation effect at a long retention interval, but not at a short interval, provides evidence against the performance-level hypothesis is that it is based on the (quite reasonable) assumption that performance levels in the literature are lower in the long-interval conditions than they are in the short-interval conditions. We tested this assumption by using the meta-analysis data. We defined a short retention interval as one in which the study and testing phases of the experiment occurred in a single experimental session (typically less than a 30-min retention interval) and long retention intervals as ones in which the memory test was given at least 24 h after the study phase. As noted earlier, this classification of the 44 cases used in the meta-analysis is given in Table 1.

The mean recognition rates for the control and misled conditions from the short- and long-interval conditions are presented in Figure 2. Somewhat unexpectedly, these data showed that performance in the control conditions was higher in the conditions with long retention intervals than in those with short retention intervals ($p = .01$). Although these results may seem counterintuitive, it is important to keep in mind that researchers are typically quite sensitive to the problem of floor effects when using delayed retention tests, and hence the

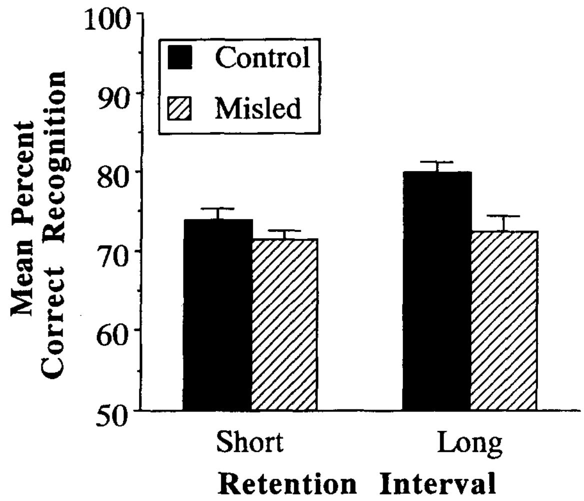

Figure 2. Mean percent correct recognition (and standard error bars) for the control and misled conditions from the short- and long-interval conditions.

materials and procedures used in the studies with long retention intervals may have been designed to raise performance levels. As noted earlier, this is why Belli et al. (1992) intentionally and appropriately confounded encoding conditions with retention interval—to produce below-ceiling performance in the short-interval conditions and above-chance performance on the delayed tests.

Regardless of what factors are responsible for producing the higher recognition rates in the long-interval conditions, these data do lead to an interesting prediction. According to the performance-level hypothesis, there should be a greater misinformation effect in conditions with long retention intervals than in those with short retention intervals. The data presented in Figure 2 are consistent with this prediction. A 2 (condition: control, misled) × 2 (retention interval: short, long) mixed-factor analysis of variance (ANOVA) revealed that the condition × retention interval interaction was significant [$F(1,42) = 7.52, p < .01$].

Although the results from the meta-analysis provide support for the performance-level hypothesis, they do not indicate whether this relation is due to variable(s) that could be responsible for producing the differences in performance levels (e.g., item availability; cf. Chandler, 1989), or whether they reflect sampling error. If the correlation is due solely to sampling error, then the empirical data should reflect one consequence of such sampling error, namely, that the relation between control performance and effect size should be symmetrical. Just as the effect size should be large (and positive) when control performance is high, it should also be large (but negative) when control performance is low. In contrast to this, the data presented in Figure 1 reveal a rather marked asymmetry: There are very few cases in which there is a large negative effect size. There are two possible explanations for this discrepancy between the actual data and what would be expected on the basis of a sampling error interpretation.

The first explanation is a possible "file drawer effect." Since there is no apparent theoretical basis for expecting performance to be worse for the control items than for the misled items, researchers may be reluctant to attempt to publish such findings. That is, the asymmetry in the empirical data may reflect a biased sampling of experimental results. Note that if this account were viable, it would mean that there are about as many unpublished experiments that have found a significant reverse misinformation effect as there are published experiments that have found a significant misinformation effect ($n = 14$). Since this seems quite unlikely, we reject this account as a viable explanation of the relation between recognition levels and the misinformation effect.

The second possibility (and the one that we favor) is that the misinformation effect is a real memory phenomenon and one that deserves further investigation. Our meta-analysis indicates that (1) performance level is one variable that plays an important role in producing the misinformation effect, and (2) considerable care needs to be taken in making simple across-experiment comparisons to assess the effect of variables of interest. This second point was made clear when we examined the effect of retention interval. Few studies report data from conditions with both short and long retention intervals, and, as a consequence, it is difficult to disentangle the effect of retention interval from other factors that are confounded in the across-experiment comparisons. Critics may argue that this same problem holds true for the present meta-analysis. We would counter this argument by noting that when all of the available data in the meta-analysis are included, the chances of discerning important trends in the data are increased.

Summary

Since the modified recognition test was introduced by McCloskey and Zaragoza (1985), there has been conflicting evidence concerning whether a misinformation effect can be obtained with this measure. The data and analyses presented here demonstrate that misleading postevent information can indeed produce memory impairment when performance is assessed with the modified recognition test. Although the misinformation effect is well documented by the meta-analysis, it is also clear that the effect is not obtained under all conditions. Although additional experimental work is required to elucidate the boundary conditions for producing the effect, the results presented here indicate clearly that memory impairment is a very real effect that warrants further study.

One factor that has been suggested as an important determinant of the misinformation effect is the length of the retention interval (Belli et al., 1992; Chandler, 1989). Unfortunately, there are very few studies available in which retention interval is varied within the same experiment, or even under the same general conditions. Here again, there is a need for further systematic research designed to disentangle the effect of retention interval from other possible confounding factors. Age is another variable that deserves closer examination, since there have been few attempts to developmentally chart the influence of misleading postevent information. There is reason to believe that susceptibility to misinformation may not be age invariant. For example, Toglia, Ross, Ceci, and Hembrooke (1992) found a significant misinformation effect with preschoolers (4-year-olds), but not with second graders (8-year-olds).

Finally, we argue that it would also be useful to include a variety of retention measures in studies of the misinformation effect. The misinformation effect paradigm is essentially a retroactive interference paradigm, and there is evidence that, at least in paired-associate tasks (Postman & Stark, 1969), retroactive interference effects are much smaller in recognition than in recall (see Postman & Underwood, 1973). By varying the type of retention test given to subjects, we can further increase our understanding of the misinformation effect. Belli, Lindsay, Gales, and McCarthy (1994) have recently reported a study in which they obtained a misinformation effect by using a variant of the modified free-recall test developed by Barnes and Underwood (1959). Belli et al.'s (1994) study demonstrates that the misinformation effect can be studied with measures other than recognition tests and also serves to reinforce the main conclusion derived from our meta-analysis—that the misinformation effect is indeed a real memory phenomenon.

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NOTES

1. In McCloskey and Zaragoza's (1985) study, as well as in the vast majority of the other studies included in the meta-analysis, the assignment of items to conditions (control, misled) was counterbalanced across subjects. Hence, the differences across conditions are not attributable to item effects.

2. In a series of computer simulations, we (Toglia, Payne, & Anastasi, 1991) have confirmed that a positive correlation between control performance and the misinformation effect can result from sampling error alone. These computer simulations also confirmed that sampling error of the type described here will yield a symmetrical relation between control performance and the magnitude of the misinformation effect. A description of these computer simulations is available from the first author.

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