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Abstract

Eyewitnesses are often called upon to report information about what they have seen. A wealth of research from the past century has demonstrated, however, that eyewitness memory is malleable and vulnerable to distorting influences, including the effects of misinformation. In this article, we review recent developments in research related to the misinformation effect, including individual differences in susceptibility, neuroimaging approaches, and protective interview procedures that may better elicit accurate event details. We conclude with a section on related false memory research.

Keywords

eyewitness, memory, law, misinformation

Twenty-five people died when a Metrolink commuter train collided with a Union Pacific freight train near Los Angeles in September of 2008 (Steinhauer, 2008). With millions of dollars in lawsuit payouts at stake, federal accident authorities began an investigation of the deadly crash and had to decide a key issue: Did the conductor pass legally through a green light, as four eyewitnesses maintained? Or did he sail through a red light, distracted by sending and receiving text messages? The conductor died in the crash, so he could not be asked. If he were at fault, the railroad company that was responsible for hiring and supervising him would be liable. If the signal malfunctioned, another company would be on the hook. After an extensive investigation, the authorities decided the eyewitnesses were wrong. The signal was red, and the engineer's text messaging was a major contributor to the accident. Is it possible that four eyewitnesses—including a conductor, a security guard, and two railroad enthusiasts—were all mistaken about such a crucial detail? The answer is yes. Eyewitnesses make mistakes, multiple eyewitnesses can all be wrong, and their erroneous testimony can have enormous consequences.

How is it possible that so many witnesses could all be so wrong? Eyewitnesses are called upon not only to remember details of events but also to describe what people look like and to decide how confident they are in the accuracy of their memories. They are often asked to remember things they saw in extremely stressful circumstances, sometimes months or even years after the fact. They are frequently bombarded with information following the event they witnessed, such as other witnesses' reports, investigator feedback, leading questions, and pressures to be both accurate and helpful. In the face of these

challenges, eyewitnesses misremember. In a recent discussion of the distorting effect witnesses have on the memory of other witnesses, Wright, Memon, Skagerberg, and Gabbert (2009) proposed three accounts of why eyewitnesses come to report incorrect information. First, a witness's report may be altered due to normative social influence. That is, a witness may decide that the cost of disagreeing with law enforcement—or with other witnesses—is too high, and so he adjusts his report accordingly. A second possibility is that through informational social influence processes, a witness comes to endorse a version of events that is different from what he remembers because he believes it to be truer or more accurate than his own memory. Finally, a witness's memory can become distorted, sometimes as the result of being exposed to incorrect or misleading information. This third possibility, known as the misinformation effect, is the focus of the current review. Advances in misinformation research concerning individual differences, neurophysiological correlates, cognitive interviewing, and related research paradigms are reviewed.

What Is the Misinformation Effect?

In the wake of more than 30 years of research, an ever-growing literature continues to demonstrate the distorting effects of misleading postevent information on memory for words, faces, and

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details of witnessed events (see Loftus, 2005, for a review of the misinformation effect). In a typical misinformation experiment, research subjects are shown materials (e.g., photographs) and are then exposed to deliberately misleading information about what they saw. In a final testing phase, many subjects will inadvertently incorporate elements from the misleading information into their memory for the original source material. For example, Stark, Okado, and Loftus (2010) showed subjects a series of photographs that depicted a man stealing a woman's wallet and hiding it in his jacket pocket. Later, subjects heard recorded narratives describing the slides. Embedded in the narratives were several pieces of misleading information (e.g., "Then the man hid the wallet in his pants pocket"). Finally, subjects were asked questions about details from the photographs, such as "Where did the thief hide the woman's wallet?" A substantial number of those subjects not only reported that the thief hid the wallet in his pants pocket but they also reported that they remembered that information from the photographs, not the narratives.

Who Is Vulnerable?

Nobody is immune to the distorting effects of misinformation. Building on the adult literature, misinformation effects have been obtained in myriad subject samples, including infants (Rovee-Collier, Borza, Adler, & Boller, 1993), and even animals (e.g., Schwartz, Meissner, Hoffman, Evans, & Frazier, 2004). Nonetheless, there is evidence that certain types of people are especially vulnerable to misinformation effects. For instance, very young children and the elderly are more susceptible to misinformation than adolescents and adults (see Davis & Loftus, 2005). Also especially vulnerable are subjects who report lapses in memory and attention (Wright & Livingston-Raper, 2002). What do these findings tell us about the underlying mechanisms driving the misinformation effect? One argument is that a poverty of cognitive resources necessitates an increased reliance on external cues to reconstruct memories of events. As Loftus (2005) points out, misinformation effects are easier to obtain when subjects' attentional resources are limited. Similarly, people who perceive themselves to be forgetful and who experience memory lapses may be less able (or willing) to depend on their own memories as the sole source of information as they mentally reconstruct an event.

Recently, two major studies containing more than 400 subjects have explored cognitive ability and personality factors as predictors of susceptibility to misinformation. In each study, subjects viewed slides of two crimes and later read narratives of the crimes that contained misinformation. Those subjects who had higher intelligence scores, greater perceptual abilities, greater working memory capacities, and greater performance on face recognition tasks tended to resist misinformation and produce fewer false memories (Zhu et al., 2010a). Certain personality characteristics were also shown to be associated with false memory formation, particularly in individuals with lesser cognitive ability. Specifically, individuals low in fear of negative evaluation and harm avoidance, and those high in

cooperativeness, reward dependence, and self-directedness were associated with an increased vulnerability to misinformation effects (Zhu et al., 2010b). In other words, it seems that personality variables may be helpful in understanding the processes underlying memory distortion following exposure to misinformation but less so in individuals with superior cognitive ability. These interactions may help explain why individual difference results have not always replicated in false memory research.

Misinformation and Neuroimaging

Relatively new but increasingly popular tools for exploring the effects of postevent information on memory include a set of highly specialized neuroscientific methods which include functional magnetic resonance imaging, or fMRI. In a typical fMRI-based behavioral experiment, subjects undergo traditional experimental procedures in an MRI scanner, during which functional images of oxygenated blood flow in the brain are collected. The resulting images can be analyzed and interpreted as differential brain activation associated with particular tasks. Functional MRI, therefore, is a useful and noninvasive tool for examining the neurobiological correlates of behavior.

Scientists have begun to investigate brain activity associated with the misinformation effect. In a recent study (Stark et al., 2010), subjects were shown a series of photographs and later listened to an auditory narrative describing them, which included misleading information. Soon afterward, they were placed into an MRI scanner and given a test of their memory for the photographs. Functional neuroimaging data revealed similar patterns of brain activity for true and false memories, but the true memories (formed by visual information) showed somewhat more activation in the visual cortex while the false memories (derived from the auditory narrative) showed somewhat more activation in the auditory cortex. As the researchers noted, these results are congruent with the sensory reactivation hypothesis (Slotnick & Schacter, 2004, 2006), which in part proposes that the same sensory regions activated in the brain during encoding will be reactivated during retrieval. These results suggest that there may be differing brain activation patterns for true and false memories when they are encoded in different sensory modalities.

Research that involves neuroimaging and other neuroscientific measurement techniques are promising for discoveries about the effects of misinformation on memory: They can provide glimpses into how different neurological processes underlie true and false memories. At the present time, however, it would be wise to err on the side of caution in the application of these findings. Although some differences were found, the patterns of brain activation associated with true and false memories in Stark et al.'s (2010) study were not reliably distinct, and other small differences in brain activation (unrelated to the sensory reactivation hypothesis) were not fully accounted for. Furthermore, data from fMRI studies are often averaged both within and across participants, which makes interpretation at the individual level of analysis difficult. Although functional

neuroimaging is elaborate and cutting edge, it has yet to provide a sure-fire way to confidently judge whether or not a particular person's memory is accurate.

Protecting Against Misinformation Effects

Not surprisingly, some effort has been focused on ways to protect against the distorting effect of misinformation. One technique for improving the accuracy and completeness of an eyewitness's recollection is known as the *cognitive interview*, a set of rules and guidelines for interviewing eyewitnesses (see Wells, Memon, & Penrod, 2006, for a review). The CI recommends, for example, the use of free recall, contextual cues, temporal ordering of events, and recalling the event from a variety of perspectives (such as from a perpetrator's point of view). Also, the CI recommends that investigators avoid suggestive questioning, develop rapport with the witness, and discourage witnesses from guessing. In one recent study, subjects viewed an 8-minute film depicting a robbery (Memon, Zaragoza, Clifford, & Kidd, 2009). Later, subjects were given either a CI or a free-response control interview, followed by suggestive questioning about events not depicted in the film. Results indicated that, consistent with earlier findings, the CI produced more correct details than did the free-response procedure. One week after the interview procedure, subjects were given a recognition test for items in the video, and subjects incorporated details from the suggestive questioning into their memory for the event. Results showed that the CI deterred the effects of suggestion, but only when it came *before* the suggestive interview. Though the investigative process would ideally be free of all suggestive influence, a properly implemented cognitive interview may help protect the integrity of an eyewitness's memory.

Related Lines of Research

In addition to the classic misinformation paradigm, researchers have developed other ways to demonstrate that even the subtlest suggestions can produce astonishing false witness reports. For instance, a handful of studies have emerged in which subjects are simply asked if they have seen video footage of well-known news events, when in fact no such video footage exists. One study found that 40% of a British sample was willing to report having seen nonexistent footage of a bus exploding in the 2005 London terrorist attacks (Ost, Granhag, Udell, & Hjelmstätter, 2008). Of the subjects who claimed they saw the footage, 35% described memories of details that they could not have seen. Another study (Sjödén, Granhag, Ost, & Hjelmstätter, 2009) found that 64% of a Swedish sample claimed to have seen nonexistent video footage of an attack on the Swedish foreign minister, and 19% went on to describe details in the form of written narratives. The ease with which these studies elicited blatantly false memory reports is striking.

Research has also shown that suggestion can also shape autobiographical memory. Beginning with Loftus and Pickrell's Lost in the Mall study (1995), a series of studies have

successfully used personalized suggestion (or other suggestive techniques) to plant false memories of traumatic childhood events (Porter, Yuille, & Lehman, 1999), receiving a painful enema (Hart & Schooler, 2006), and even impossible events such as meeting Bugs Bunny—a Warner Brothers character—at Disneyland (Braun, Ellis, & Loftus, 2002). These lines of research represent a broad area in their own right, with controversies and applications that are beyond the scope of this paper. However, they show that misleading postevent information has implications beyond merely mistaking a green traffic light for a red one or misremembering where a pickpocket hid a woman's wallet. If suggestion can cause us to remember experiences that never occurred, what does this say about the reliability of eyewitness evidence in general? If merely asking people if they have seen events they could not possibly have witnessed represents a strong enough suggestion to cause such staggering errors, what are the implications for witnesses who were present at a crime scene but never saw a perpetrator's face, only to hear it described later? Researchers continue to investigate what conditions lead to memory distortion, which types of people are most susceptible, and how best to prevent the distorting effects of postevent information. Unfortunately, in spite of recent scientific advances, many eyewitness errors continue to go undetected and can have devastating consequences.

Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

Recommended Reading

- Brainerd, C.J., & Reyna, V.F. (2005). *The science of false memory*. New York: Oxford University Press. A book, over 500 pages long, that describes nearly everything a reader would want to know about false memories.
- Loftus, E.F. (2005). (See References). Summarizes some of the key studies that have contributed to more than three decades' worth of research on the misinformation effect.

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