# 22

# MISINFORMATION EFFECT

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*Memory is a complicated thing, a relative to truth, but not its twin.*
Barbara Kingsolver, *Animal Dreams*

Our memory is an amazing entity with the ability to provide us with the continuous sense of self described by William James. Memory operates in an extremely efficient manner, allowing us to recall more pleasant than unpleasant memories and enough detail to reconstruct past experiences with reasonable accuracy. Memory is, however, subject to distortion, the study of which has historically been rooted in interference theory. Interference theory states that the reason we forget is that other memories in long-term memory impair our ability to retrieve the target memory. Memory involves a reconstructive process: It is vulnerable to interference from other experiences, especially from experiences that occur after a to-be-remembered event.

We describe contemporary studies of memory distortion, focusing on the "misinformation effect." This effect refers to the tendency for post-event misleading information to reduce memory accuracy for the original event. We begin our discussion with a brief overview of forgetting as a function of event encoding and event retrieval errors. We discuss various laboratory techniques that demonstrate the misinformation effect. The misinformation effect is a robust phenomenon whose underlying mechanism remains unclear. For example, we do not know who is susceptible to misinformation. We also do not know what kind of post-event information is necessary to distort a memory, nor how much can we distort that memory. Finally, we do not know what the misinformation effect says about memory's permanence.

Beginning with naturally occurring memory distortions, through use of the suggestion of misleading details, we discuss empirical demonstrations of the misinformation

effect including the most complex misinformation effect of all: the creation of memories for entirely false events. We briefly describe data from an experiment that examined consequences of creating a false memory of being attacked by a small dog as a young child, and provide a simple methodology for demonstrating the misinformation effect in a classroom. Finally, we explore the difficulty in distinguishing true from false memories and explore recent research examining the neural mechanisms of the misinformation effect.

## Memory primer: Encoding, storage, and retrieval

Memory consists primarily of information encoded and stored in such a way as to facilitate retrieval of that information. The quality of what is encoded and the way it is encoded directly influence the subsequent retrieval of that information. Numerous factors affect the encoding process, beginning with attention. In order for the encoding process to succeed, we must attend to information. Additionally, the depth to which we process the encoded details influences the encoding process. Elaborating on information that is observed, particularly by linking the event or detail to previously learned information rather than experiencing the information with no conscious effort to remember it, will produce better encoding. Moreover, unusual, unexpected, and unfamiliar information tends to stand out in our mind, resulting in good encoding. It is safe to say that the accessibility of information that is poorly encoded or not encoded in memory at all will not improve with the passage of time.

Researchers typically view remembering as a reconstructive process. The memory for an event is not stored in its entirety, as an exact replica of the event. Rather, the event is broken and organized into personally meaningful pieces. These mental representations capture the gist or essential meaning of the event. Retrieval involves a mental re-enactment of the original experience. This reconstructive process involves distortions, in the form of omissions, elaborations, or misperceptions. Some theorists have argued that the success of retrieving previously encoded details depends, to a large degree, upon the extent to which the retrieval context matches the original encoding context (Tulving & Thompson, 1973).

Related to the organization of memory is research done on schematic memory. The definition of schema is an organized pattern of thought about some aspect of the world, such as events, situations, objects, or a class of people (Bartlett, 1932). Our schematic knowledge may play a role in each of the primary memory processes: encoding, storage, and retrieval. The encoding process, for example, is influenced by what we attend to and what we use to guide our understanding. Extracting an event's gist directs the storage method, in that highly associated information is stored together and distributed across the cortex. Schematic knowledge also can be very useful in the reconstructive process of memory. When retrieval occurs, our schemata aid the process, in that we may rely on what most likely happened and construct memories that allow us to provide a desired level of detail without having to reencode the information each time we experience it. Unfortunately, a schema

can distort memory because as we store schematic knowledge we do not have to attend to everything in our environment. When we rely on our schematic knowledge to report a memory, we usually remember things as being quite typical. Since we use our knowledge to identify an event or situation and to form a representation of that event, the errors committed when we "fill in the gaps" may negatively influence the accuracy of our memory.

## Misinformation

By the middle of the 20th century, many scientists were searching in vain for the engram, a hypothetical memory trace that left an identifiable and indelible physical trace in the brain. The engram was believed to be both permanent and localizable, two views that dominated early cognitive neuroscience. The permanence theory gained support in the 1950s when neurosurgeon Wilder Penfield began operating on patients with epilepsy. During surgery, he kept patients awake but anesthetized them so they could respond when he stimulated certain areas of the brain. He claimed that by using this technique he accessed memories. The media embraced this concept and communicated the hype to the public as well as to the scientific community. The permanence theory was given a big boost. In reality, Penfield operated on 1,100 patients, and only 40 responded by producing anything like a memorial response when the temporal lobe was stimulated. Only five of those 40 reported a complete episodic memory, and some of these could be ruled out as real memories by other evidence. When Elizabeth Loftus and her colleagues (Loftus, 1975; Loftus, Miller, & Burns, 1978; Loftus & Palmer, 1974) claimed that people's memories are malleable after exposure to misleading post-event information, the social and theoretical implications of this finding caused a flurry of interest in the misinformation effect.

In their original studies, Loftus and colleagues demonstrated how question wording and the introduction of misleading post-event information influence what is remembered (see Chapter 20). In one study, Loftus (1975) showed participants a film of an automobile accident, and then asked half of them, "How fast was the white sports car going when it passed the barn while traveling along the country road?" No barn was shown in the film; however, many of the participants who had been asked about the barn claimed to have seen it in the film. In another study, participants answered one of the following questions about a car accident depicted in a film that they had seen: (1) How fast were the cars going when they hit each other? or (2) How fast were the cars going when they smashed into each other? (Loftus & Palmer, 1974). The researchers found that the latter question produced higher speed estimates than did the former question. Simply changing the word "hit" to "smashed into" affected the subject-witness's memory for the original event. In another study, participants watched a slide sequence involving a car/pedestrian accident. In the slide sequence, a car arrives at an intersection, turns right and hits a pedestrian. Half the participants saw a yield sign, while the remaining participants saw a stop sign. Later, some participants were asked a question containing a misleading suggestion

about either a stop sign or a yield sign (whichever sign they had not seen in the slide sequence). When tested for their memory of the original slides they had seen, many of the misled participants mistakenly claimed that they had seen the sign that had been suggested rather than the sign that they had actually seen (Loftus et al., 1978). The traffic-sign study is also used as basis for a classroom demonstration given in Text box 22.1. In sum, these studies demonstrate that misleading post-event information affects what people erroneously report about the past.

## TEXT BOX 22.1 MISINFORMATION STUDY

For a classroom demonstration of the misinformation effect, we suggest using a modified version of Loftus et al.'s (1978) study. To demonstrate the effect in the most straightforward manner, we will use one independent variable, the type of information, with three levels (consistent, inconsistent, neutral). Dependent variable is the frequency of choosing the correct slide in a forced-choice recognition test. Based on the replicability of the misinformation effect, and the conversion of odds ratios to effect sizes (Blank & Launay, 2014), we assume a large effect size (Cohen's $d = .8$). Thus, with $\alpha = .05$ and $1 - \beta = .95$, plan on a sample size of $N = 42$ per group. To test for statistically significant differences between conditions, a $\chi^2$-test can be used (or a binomial test, if expected frequencies are below 10).

### Method

#### *Materials and procedure*

A series of 8 color slides are shown in a sequential manner to depict an auto-pedestrian accident. The modified set may be accessed at the following URL: [https://www.routledge.com/products/9781138903425]. The set includes the following 8 slides (plus 8 additional distractor slides):

- a black car approaching on a neighborhood street
- the black car passing a red car driving in the opposite direction
- the black car approaching an intersection
- the black car stopped at a stop sign with a pedestrian on the right
- a female pedestrian, walking her dogs, crossing the street in front of the car
- the pedestrian lying on the road in front of the black car
- the driver of the black car getting out of the car
- the driver of the black car speaking to the injured pedestrian

Eight questions, including one critical question, are administered immediately after participants view the slides. These questions serve as a memory test

for the information presented in the slide sequence, and are as follows (note that the three versions of the critical question are in italics):

- Did you see the black car approaching from a distance?
- Did you see a bicycle?
- Did you see the bridge?
- *Was the male pedestrian on the right or left of the black car while it was stopped at the intersection with the stop sign?* (consistent)
- *Was the male pedestrian on the right or left of the black car while it was stopped at the intersection with the yield sign?* (inconsistent)
- *Was the male pedestrian on the right or left of the black car while it was stopped at the intersection?* (neutral)
- Did you see the taxi cab across the street?
- Was the pedestrian who was hit a man or a woman?
- Was the pedestrian walking one or two dogs?
- Did the driver get out of the car and speak to the injured pedestrian?

All participants view the slide sequence showing a stop sign at the intersection. Participants are then randomly assigned to receive consistent, inconsistent, or neutral information with respect to the original traffic sign viewed in the slide sequence. This information is delivered through administration of the eight questions. Participants receiving information asking about the stop sign are receiving information consistent with the slide series (consistent). Another third of the participants receive information where they have it suggested that they saw a yield sign (inconsistent). The final control-condition participants receive no information (neutral).

A yes-no recognition test is administered after a brief (we suggest 15–20 minutes) filler task. Eight pairs of test slides are shown to participants who report which slide of each pair they had seen before. The critical slide pair, the scene showing either the original stop sign or the misleading yield sign, is randomly placed within the 8 pairs of slides.

## Results

What proportion of participants correctly chooses the stop sign from the original slide-show sequence? With the recognition test administered immediately after the exposure to the misinformation, Loftus et al. (1978) found that participants who received the information that was inconsistent with what they had actually seen were much less accurate in their responses compared to the participants in the other two conditions. In addition, when the retention interval is increased to two days (see Figure 22.1) and we compare the response of those in the neutral condition with the other two groups, receiving the consistent information improved performance on the recognition task. Along with

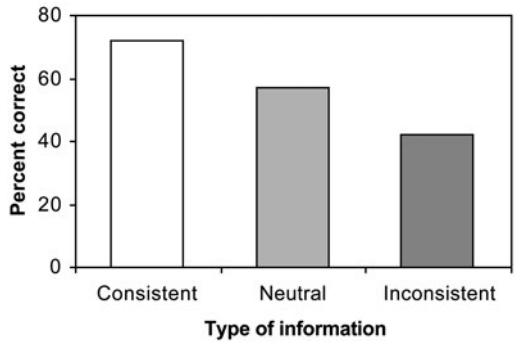


**FIGURE 22.1** The effect of the type of information on the proportion of correct answers given on the recognition test two days after viewing the slide show and completing the questionnaire.

the fact that the type of information has an effect on memory for the original information, Loftus et al. demonstrated that delay of the questionnaire containing the misleading information also hindered memory performance. Apparently, time allows the original memory trace to weaken, thus making it easier for an erroneous memory report to be given.

## *Theoretical accounts of the misinformation effect*

About the same time as the first misinformation studies were reported, there was also a rising concern regarding the reliability of eyewitness testimony. The misinformation effect had important practical implications. Soon thereafter, a theoretical issue arose. The very nature of memory was now in question. When participants had seen a stop sign, but received a suggestion about a yield sign, and then claimed that they saw a yield sign, what happened to the stop sign in their memory? Was it still there, but perhaps harder to retrieve? Was it erased or altered in the process of absorbing the suggestive information? McCloskey and Zaragoza (1985) attacked this memory-impairment hypothesis by claiming that "misleading post-event information has no effect on memory for the original event." (p. 2) The misinformation results were not in question, but the interpretation was. McCloskey and Zaragoza's key arguments involved the procedure used in these studies. They argued that the acceptance of misinformation occurred because:

- Participants never encoded the original information and remembered the post-event information.
- Participants encoded both the original and the post-event information and deliberated about what to report, eventually reporting the information they surmised the questioner is looking for.
- The original information was just forgotten.

McCloskey and Zaragoza proposed a modified procedure in an attempt to account for participants who fall into any of the categories above. They conducted six experiments using both this modified procedure and the original. The *modified* procedure was identical to the original procedure except the test was different. The original procedure had participants choose from either the original event/item or the misleading event/item. In the modified procedure, participants chose between the original event/item and a *novel* event/item. The misleading information was not an option. McCloskey and Zaragoza hypothesized that if the misleading information altered memory for the original event, when that information was not an option at test, memory for the original information would be selected less often than selected by those in the control condition.

Collapsing over many experiments McCloskey and Zaragoza successfully replicated the misinformation effect using the original procedure: Participants in the control condition correctly reported the original information 72% of the time, whereas the misled participants correctly reported the original information only 37% of the time. However, the results were different in the modified procedure. Here, control participants correctly reported the original information 75% of the time, while misled participants correctly reported the original information 72% of the time. The researchers' conclusions were direct (McCloskey & Zaragoza, 1985, p. 7):

> Misleading post-event information does not impair participants' ability to remember what they originally saw. In other words, misleading information neither erases the original information nor renders it inaccessible.

McCloskey and Zaragoza explained these results with factors other than memory-impairment, specifically, either task demands or strategic effects. Zaragoza, McCloskey, and Jamis (1987) tested the modified and original procedures with recall rather than recognition and supported their belief that differences between the misled and control conditions in the original procedure are due to factors other than memory-impairment. McCloskey and Zaragoza asserted that the test should be such that process-of-elimination strategies can be controlled.

Subsequent experiments designed to reduce or eliminate strategic effects have demonstrated effects of memory-impairment (see Ayers & Reder, 1998, for a review). Moreover, the modified test may be insensitive to memory-impairment. When overall memory performance is low, the effect may need the additional strength of the exposure to the misleading information once again at test. More recent studies using false images and videos (Wright, Wade, & Watson, 2013) supported the impact of repetition of the post-event information on memory strength, and in a series of experiments, Chan and LaPaglia (2013) demonstrated that even after successful retrieval, original memories were susceptible to misinformation if reactivated prior to relearning. They proposed that this susceptibility may be due to disruption of reconsolidation.

It seems that each of the explanations offered accounts for some of the findings but as yet we have not developed a theory to explain all the results. Metcalfe (1990,

in Ayers & Reder, 1998, p. 19) proposed her CHARM theory, a memory model that accounts for the misinformation data by means of memory trace alteration. This is a single-trace model that explains the integrated and blended memory data but falls short of explaining the small effects sometimes seen using the modified procedure.

Ayers and Reder (1998) proposed an activation-based model that might explain the various misinformation effect findings in terms of a source of activation confusion (SAC) model of memory. This multi-trace model predicts that in our classic misinformation example, a participant might be aware of the high activation of the concept "yield sign" but be unaware of the reason that it was activated. "Yield sign" would be more highly activated at test than the original "stop sign" because it had been activated more recently. This model is consistent with the ideas expressed by Kelley and Jacoby (1996), that under some conditions, the source of activation is unclear. If the source is either unavailable or unknown, it may be misattributed, resulting in memory errors. This model is, however, at direct odds with an integration/blending theory. If the memory trace is altered or overwritten, there can be no source misattribution because there is only one source. In summary, our colleagues Hyman and Pentland (1996) may have said it best: "Although the misinformation effect is easily replicated, the explanation of such memory errors is hotly contested." (p. 101)

Today, there seems to be a consensus among cognitive psychologists that no single process is responsible for all of the misinformation effects (Frenda, Nichols, & Loftus, 2011). In other words, a misinformation response can arise for a number of different reasons. Sometimes the original and the misinformation items can coexist. Sometimes, the misinformation appears to weaken or impair the original item. But whatever the process that leads to a misinformation response, the empirical findings, when taken as a whole, support the reconstructive nature of memory and illustrate how this reconstruction leaves memory susceptible to errors.

### *Manipulations of the misinformation effect*

Many factors influence the effectiveness of misinformation. First, the passage of time renders the original memory less accessible, thereby allowing misinformation to "creep in" undetected. Second, the subtler the discrepancies are between the original information and the post-event information, the stronger the misinformation effect. Third, the more ignorant one is of the potentially misleading effects of post-event information, the more susceptible s/he will be to the misinformation effect.

Who is susceptible to the misinformation effect? One somewhat unusual misinformation study provides insight into just *who* is most likely to accept misinformation (Loftus, Levidow, & Duensing, 1992). At a science museum in San Francisco, approximately 2,000 visitors participated in a typical misinformation study. Participants viewed a short film and then some of the participants received misinformation while others did not. All of the participants then answered questions about the film. While most misinformation studies have been conducted in University laboratories with college students, this particular study included people

ranging in age from 5 to 75 years, providing a unique opportunity to gather information on the effect of age and misinformation. Consistent with other studies involving children (Ceci, Ross, & Toglia, 1987), the youngest participants showed large misinformation effects. Additionally, the elderly showed a large misinformation effect, too (Loftus et al., 1992).

The preceding discussion has focused primarily on the fact that memory details are sensitive to misinformation. For example, subtle word choice embedded within post-event information can influence memory (for more examples, see Chapter 20). Such memory distortion can be seen even in "flashbulb memories," memories named for their highly emotional, meaningful, and subjectively permanent nature. One could imagine how the following, subtly worded question could lead people to remember seeing details about the September 11 terrorist attacks that they never saw: "Did you see the explosion after seeing the plane crash into the Pentagon during the September 11 terrorist attacks?" There was no footage of the plane crashing into the Pentagon. However, the question suggests that such footage not only exists, but that the individual might have seen it. This suggestion, coupled with the knowledge that a plane did, in fact, crash into the Pentagon, might lead people to think mistakenly that they saw the plane crash (Ost, Vrij, Costall, & Bull, 2002).

In addition to changing memory for details, misinformation can also plant entire events into a person's memory. In one study, 25% of participants either partially or wholly accepted the false suggestion that they had been lost in a shopping mall at the age of five (Loftus & Pickrell, 1995). Likewise, Hyman, Husband, and Billings (1995) convinced many of their participants that, as children, they had knocked over a punch bowl at a wedding and spilled punch on the bride's parents. Both studies utilized a procedure in which the researchers acquired three true memories from the participants' parents. The researchers then provided participants with the true memories and the false memory. Participants were asked to try to remember the events and to describe them in detail. Not only did nearly one quarter of the participants come to believe that the false event had occurred, but they also elaborated on the false event (e.g., "I do remember her [an elderly lady] asking me if I was lost, . . . and asking my name and then saying something about taking me to security"; Loftus & Pickrell, 1995, p. 724).

There are, of course, other ways to increase one's confidence in various childhood events. Mock personality profiles and dream interpretations are procedures that utilize the power of suggestion to increase one's subjective confidence in events that never occurred. Participants might learn that their personality profiles reveal that, as young children, they had been attacked by a dog. Or a dream "expert" might interpret a dream as meaning that, as a young child, one had to be rescued by a lifeguard. Such misinformation can increase participants' confidence in the critical events (Mazzoni, Loftus, Seitz, & Lynn, 1999).

Another form of suggestion used to inflate confidence in childhood events involves imagining an event in detail that never occurred. For example, Garry, Manning, Loftus, and Sherman (1996) asked participants about a variety of childhood events, including whether they had broken a window with their hand. Next, some

participants imagined in detail running through the house as a child and tripping and falling and breaking a window with their hand, cutting themselves and bleeding. This type of imagination exercise significantly increased participants' confidence that they experienced this event in their childhood. Additional research on "imagination inflation" established the utility of this procedure (see Drivdahl & Zaragoza, 2001).

Another technique used to create false memories involves altered photographs. Wade, Garry, Read, and Lindsay (2002) asked participants about a variety of childhood events, including riding in a hot air balloon. The researchers then obtained childhood photographs of their participants and inserted these pictures into a photograph depicting a hot air balloon ride. After participants saw themselves riding in a hot air balloon, they began to "remember" the ride, even though the experience had been completely fabricated. Recent techniques continue to capitalize on the development of technology. Not only have we gotten very good at altering photographs, but an increasing literature demonstrates the suggestive power of exposing people to altered video images of their past behavior (Nash & Wade, 2009; Nash, Wade, & Brewer, 2009).

### *Consequences*

We know that there are consequences of true experiences that we no longer remember. One of us (JP) knows firsthand of an individual (her daughter) who retained her fear of dogs long after she had forgotten having been attacked by a large dog when she was two years old. What if the daughter had had a false belief about being attacked? Would this also lead to a similar kind of lingering fear? More generally, are there long-term consequences associated with creating false beliefs or memories? If a person comes to believe that they were attacked by a dog while a child, might they be more inclined as an adult to own a cat instead of a dog?

New research illustrates just how the malleability of memory in general, and specifically, the generation of false memories may be used in behavior modification therapy. Using an imagination paradigm, Clifasefi, Bernstein, Mantonakis, and Loftus (2013) successfully planted a memory of participants becoming ill after consuming a specific alcohol before the age of 16 years. The authors then noted a decrease in participants' self-reported preference ratings for that specific alcohol compared to participants' pretest ratings. The potential to influence not only negative habits we would like to eliminate, but the potential to influence nutritional selections may prove to be quite beneficial as culturally we move toward a desire for healthier living.

Braun (1999) examined the effects of misinformation, in the form of an advertisement, on one's subsequent memory for the taste of orange juice. Braun asked participants to taste orange juice and to describe its flavor. Some participants then evaluated the effectiveness of a false advertisement that described the orange juice that they had tasted 15 minutes earlier as being "sweet, pulpy and pure" (p. 323). The misinformation in this advertisement significantly altered participants'

memories a few minutes later for the original orange juice that they had tasted. Specifically, the false advertisement made participants think that the orange juice that they had tasted earlier was better than it in fact had been (see Chapter 20). The results of Braun's work, and Clifasefi and colleagues' work, suggest that it is possible to alter a true memory and to plant a false memory, with either positive or negative consequences.

### *Possible mechanisms*

What is not clear from the work we have described are the boundary conditions of the misinformation effect and the underlying mechanism responsible for memory distortion. Some have investigated the limits to what types of memories can be created through suggestion or imagination. Mazzoni, Loftus, and Kirsch (2001) argued that an event must be seen as plausible in the rememberer's culture and that it must be seen as personally plausible before one comes to incorporate the experience into his/her own autobiographical memory.

One possible mechanism that might explain memory distortion after different forms of misinformation is that of familiarity (Garry et al., 1996). Larry Jacoby and colleagues (e.g., Jacoby, Kelley, & Dywan, 1989; see also Whittlesea & Williams, 2001) have argued that many false memories arise through the misattribution of familiarity. According to this notion, when participants fluently process an event or experience, they experience a feeling of familiarity. They then search for reasons that might explain this processing fluency. If they are unable to detect an obvious source, they may attribute the fluency to past experience (see Chapters 10, 13, and 14 in this volume).

Familiarity attribution may help explain why people accept misinformation and why they increase their confidence for childhood events after imagining these events or after being told that the events likely occurred. In such cases, people will process the imagined or suggested event more fluently than they would otherwise have processed it. They will, in turn, evaluate their present processing experience. Instead of correctly focusing upon the misinformation, the imagination exercise, or the suggestion as the source of familiarity, they mistakenly attribute the familiarity to their childhood.

## Distinguishing true from false memories

### *Behavioural evidence*

Unfortunately, it is very difficult to tell whether an individual memory is real or a product of imagination or some other process. In fact, research over the past 30 years suggests that it is virtually impossible to determine whether a particular memory is real (see Bernstein & Loftus, 2009). In a quest to distinguish true from false memories, researchers compared participants' reports for true and false memories (Loftus & Pickrell, 1995). The participants used more words when describing their

true memories, and more highly rated the clarity of their true memories than they rated the clarity of their false memories. Confidence ratings revealed that people were less confident in their false memories than they were in their true memories.

Roediger and McDermott (1995) created false memories for words not presented in lists (see Chapter 21). Not only were false memories as common as true memories in the study, but participants expressed as much confidence in their false memories as they did in their true memories. Perhaps even more upsetting to those who hope to distinguish true from false memories, participants claimed to "remember" (or mentally relive) the experience of having heard words before that they had not heard. Thus, false memories were easily created, and they were virtually indistinguishable from the true memories.

Porter, Yuille, and Lehman (1999) investigated whether phenomenological and content features could discriminate between real and false memories in an effort to systematically assess the credibility of childhood memories. Porter et al. employed criteria based on the Memory Assessment Procedure (MAP). This procedure consists of seven items designed to record phenomenological (subjective) features, and five items designed to record the specific features of memories. Content analysis revealed that participants rated true memories as more vivid/clear and more detailed. Participants also expressed more confidence in true memories when compared to the implanted memories. No difference was measured in stress levels. Additionally, 40% of participants recalled the real memory from a participant perspective. That is to say, they "re-experienced the event from their own eyes" (p. 28). The remaining 60% of participants viewed the real memory from the observer perspective, meaning they could view themselves as if watching a movie. The percentages were exactly reversed when participants recalled the implanted memory: 60% saw it from the participant perspective and 40% from the observer perspective. Although this was not a reliable difference, it does suggest that real and false memories may possibly differ in terms of their phenomenological and content features.

Heaps and Nash (2001) examined differences between true and false memories. A variation of the Loftus and Pickrell paradigm was employed to plant false memories in participants. They used information from relatives to suggest to people that they had undergone certain experiences. The researchers replicated the basic finding of greater detail remembered for the true memories when compared to the false memories. On first pass, the true memories appeared different from the false memories, because they were rated as being more important, more emotionally intense, more typical, and as having clearer imagery. These distinctions were eliminated when rehearsal frequency was used as a covariate in the statistical analyses. This suggests that increased rehearsal shifts the false memory closer to the recollective experience of true memories. A final observation concerned the consequences of the target event. False memories contained less information about any consequences of the event.

The move into the legal arena often lags behind the scientific advances. It will be long after we are able to distinguish false memories from true ones in the lab that we may apply such standards to tests in the courtroom (Schacter & Loftus,

2013). Heaps and Nash (2001) illustrated the problem: "the possibility [exists] that repeated remembering of false memories over greater periods of time [longer than three weeks] may make recollective experience more complete and more like that found in true autobiographical memories" (p. 17). Few things are more rehearsed than legal testimony, traumatic memories, and events made important by police and legal proceedings. Currently, external corroboration remains the only reliable way to determine the veracity of a memory.

### *Neuroscientific evidence*

Although the behavioural influences of the misinformation effect have been studied extensively, it has only been in the past decade that the neural mechanisms of this effect have been explored. Researchers have used neuroimaging techniques such as functional magnetic resonance imaging (fMRI) and event-related potentials (ERPs) to differentiate false memories from true memories at retrieval (e.g., Baym & Gonsalves, 2010; Curran, Schacter, Johnson, & Spinks, 2001; Fabiani, Stadler, & Wessels, 2000; Kim & Cabeza, 2007). Other work has shown that stimulation of the left anterior temporal lobe with repetitive transcranial magnetic stimulation (rTMS) may reduce certain types of false memories (Gallate, Chi, Ellwood, & Snyder, 2008). After decades of studying the behavioural consequences of the misinformation effect, Loftus (2005) deplored the paucity of physiological measures of this effect and applauded the recent (at that time) work of Okado and Stark (2005).

Okado and Stark (2005) were the first to use neuroimaging techniques to investigate the misinformation effect. They extended the research at that time by using detailed vignettes as opposed to word lists in the study phase (also known as the original event phase). As an example, one of the vignettes depicted a woman showing her friend the *South Park* DVD that she had purchased, and his response. Participants viewed the vignettes while in the fMRI scanner. After a short delay, participants viewed the same vignettes, but unbeknownst to them, with changes to several critical items (misinformation phase). Using the previous example, instead of showing the *South Park* DVD, the woman showed her friend an *X Files* DVD. After two days, participants took a recognition memory test. Differences in neural activity in the left hippocampus tail and the perirhinal cortex during the original event phase and misinformation phase served as predictors for later recounting of true or false memories.

Extending the Okado and Stark (2005) paradigm, Stark, Okado, and Loftus (2010) used both visual and auditory stimuli. The original event phase utilized vignettes that participants viewed in a slide show. The misinformation phase, which occurred a day later, differed from the previous study by using a recorded narrative, where participants heard the information in the vignettes, with critical details changed. Shortly after the misinformation phase, participants entered the fMRI scanner. They read 24 sentences that briefly described events from the vignettes, and answered whether they had seen each in the original event. Outside the scanner, participants viewed the questions and their responses from the previous phase and

were asked the source of their memory (e.g., "Remembered it was in both the slides and the narrative" or "Could not remember and guessed", p. 486). Sensory reactivation was observed in both the visual cortex and auditory cortex. When stimuli were presented visually, correct recollection was accompanied by greater activity in the visual cortex. False recollection of auditory stimuli, however, was accompanied by greater activity in the auditory cortex.

Baym and Gonsalves (2010) adapted the Okado and Stark (2005) paradigm to assess how misinformation and visual imagery at encoding affect subsequent memory retrieval. Participants experienced the original event phase and the misinformation phase inside the fMRI scanner. During the original event phase, participants viewed a written description of each event, followed by photographic descriptions. During the misinformation phase, participants viewed the same initial written description, but without photographs. Participants were asked to imagine the actual event while reading the description. A day later, outside the scanner, participants took a multiple-choice recognition test, followed by a 'conflict test,' where they were asked whether there were any differences between the photograph and the written description. Greater neural activity in the ventral visual areas at encoding predicted subsequent true memories. Both true and false memories were related to greater activity in the right frontal cortex and bilateral MTL, which was not the case for forgetting. Other research has been successful in the prediction of true memories, false memories, and subsequent forgetting, outside the context of studying misinformation (e.g., Abe et al., 2013; Gonsalves et al., 2004; Karanian & Slotnick, 2014).

More recent work by Meek, Phillips, Boswell, and Vendemia (2012) has broadened the misinformation paradigm by adding deception. This research could have important implications for eyewitness testimony. Could individuals lie about an event when they do not know all the details? In this study, participants observed a series of slides that showed a crime being committed, then read a narrative that contained misinformation. Prior to the test phase, participants wore electroencephalograph (EEG) caps that recorded ERPs. Participants were then separated into one of two groups where they had to either tell the truth or lie about their recollections. The ERPs showed lateralized differences between misinformation and information that was consistent with the observed crime. There were also lateralized differences between deception and truth-telling. Such work provides exciting avenues for studying the neurophysiology of false memories.

## Conclusion

What is clear from the myriad studies of memory distortion – and, specifically, those exploring the parameters of the misinformation effect – is that misinformation can lead to memory changes, ranging from minute details of events to memory for entire false events. While the misinformation effect is a robust phenomenon, it can affect people in many ways. It can add to memory, it can just change what people report, and it sometimes appears to lead to impairments in previously stored memories.

The current comparison of true and false memories shows us that in general, the phenomenological experiences of both types of memory are indistinguishable (for details see Chapter 21). While some studies point to participants being clearer and more confident in their true memories (Loftus & Pickrell, 1995; Porter et al., 1999), others report less discernible evidence (Heaps & Nash, 2001; Roediger & McDermott, 1995). Along with technological advances in brain imaging techniques comes the potential to distinguish true from false memories at a physiological level. The ability to determine the "true" nature of a memory and exactly which areas of the brain are activated during the remembering process holds promise for both the courtroom and the therapist's office.

Heaps and Nash (2001) showed that false memories contained less information about consequences of the false event when compared to the consequences revealed when the memory was true. Future research on the consequences of memory distortion may also open a window on the issue of distinguishing true from false memories. The need to understand false memory reports and the impact on everyday actions becomes more important when we realize we are all susceptible to misinformation in myriad ways. And given that we can manipulate positive events resulting in positive consequences as well as negative, there may be therapeutic implications whereby changes in memory and associations may be beneficial in changing future behaviors.

Neuroimaging techniques can be valuable tools to help researchers distinguish true from false memories. However, it is important to use caution when drawing conclusions from these results. The data from fMRI studies reflect an average of each individual participant's results as well as across participants (Frenda et al., 2011). While providing important information about how false memories evolve, averages do not enlighten the memory researcher about the veracity of a particular memory (see Bernstein & Loftus, 2009). Certainly more work is needed on the neurophysiology of false memories elicited within the misinformation effect (see Schacter & Loftus, 2013, for possible links between the misinformation effect and what is called reconsolidation, in which reactivated memories become temporarily vulnerable to change).

## Summary

- The misinformation effect occurs when a person receives post-event information (e.g., new information after the original event) that interferes with the person's ability to accurately recall the original event.
- The misinformation effect is a very robust phenomenon.
- The underlying cognitive mechanisms remain unclear. As explanation, cognitive theories claim that either the original memory trace is altered or that the original memory trace remains intact but inaccessible.
- The effect has been found with different materials and experimental procedures and ranges from changing details of an event to planting false memories of an entire event.

- The consequences of memory distortions have important implications for several applied problems.
- As yet, we have no reliable means of distinguishing true from false memories.

## Further reading

For an excellent overview of research on the misinformation effect, see Ayers and Reder (1998). In addition, practical legal applications are explored in depth in Loftus and Ketcham's (1991) *Witness for the Defense.* For recent empirical articles, *Applied Cognitive Psychology* (published by John Wiley & Sons) and the *Journal of Applied Research in Memory and Cognition* (published by Elsevier) cover theoretical, empirical, as well as applied aspects of the misinformation effect. Additionally, Frenda et al. (2011) is well suited for a general audience.

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