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Consequences of False Memories in Eyewitness Testimony:

A Review and Implications for Chinese Legal Practice

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**Abstract**

False memories can result in severe legal consequences including the imprisonment of innocent people. False memory in eyewitnesses is the largest factor that contributes to miscarriages of justice in the United States. To date, no study has focused on how false memories possibly play a role in the Chinese legal system. The purpose of this review is to summarize the latest findings on false memory and eyewitness testimony in the literature, and to shed light on how the Chinese legal system may incorporate these experiences into practice. In essence, false memories of eyewitnesses are generated either by external misleading information or by internal cognitive processes; may guide police investigations in the wrong direction; and/or cause eyewitnesses to misidentify an innocent person as the perpetrator. Therefore, designed interview protocols such as the Cognitive Interview, warnings given to eyewitnesses and blind lineup administration may prevent or lower the risk of false memory occurrence.

Keywords: false memory, eyewitness testimony, Chinese legal practice

**Consequences of False Memories in Eyewitness Testimony: A Review and Implications for Chinese Legal Practice**

During December 2003 when Haisheng Zhang (张海生) was visiting his relatives in Lichuang County, Henan Province, China, he was detained unexpectedly by the police as a suspect for raping a 13-year old girl in the woods. He was eventually sentenced to nine years of imprisonment by the Court of Lichuang County. The most important piece of evidence used by the prosecutors was the testimony of the victim who stated that she was completely confident that Zhang was the culprit. Besides the victim’s testimony, a further three teenage girls identified Zhang from a lineup as the person who talked to and led the victim to the woods. However, there was no physical evidence to incriminate Zhang as the offender. More than a year after his conviction, another defendant, who had recently been caught, confessed to a series of sex offending cases including the one with which Zhang had been charged. Zhang had spent 480 days in prison when he was released as a result of the confession.[[1]](#footnote-2)

Zhang’s case is not the only Chinese one in which an innocent person has been falsely convicted and imprisoned because of erroneous memories. Another case, which occurred in 1990, was also recently revised: Jibin Xu (徐继彬) was wrongfully convicted of rape because he was identified by the victim as the assailant even though the police did not match his blood type with that found at the rape scene; in fact, his blood type did not match that of the real perpetrator. Sixteen years later he was proven innocent by a blood test.[[2]](#footnote-3)

In both these cases, innocent people were convicted because of the absolute reliance on eyewitness testimonies even when these included erroneous memories that implied another was guilty. In the absence of physical evidence, these testimonies became crucial. It is of importance to note that in the majority of criminal proceedings, eyewitness testimonies are regarded as most important piece of evidence (e.g., Howe, Knott, & Conway, 2018). Often there is no objective evidence such as DNA (Howe & Knott, 2015; Perterson, Hickman, Strom, & Johnson, 2013). Consequently, often legal professionals have to rely on the memory of a victim and/or witness. However, memories may be regarded as malleable and are not as reliable as people expect (Loftus, 2004; Schacter, 2012). Our memories are fallible; in other words, memories are not literally reproduced, but reconstructed when they are retrieved (e.g., Howe et al., 2018). During such reconstruction, unintentional errors might occur, which subsequently result in false memories. False memories may be defined as memories of events that did not happen, yet are experienced as real (Loftus, 2005). Such false memories can occur in many different situations such as one misremembering that he or she put the car keys on the table while in fact the keys were still in the car. Furthermore, false memories are often relatively innocuous. However, when false memories occur in the legal arena, the consequences thereof can be quite dramatic especially when these memories involve false accusations of sexual abuse or faulty eyewitness identifications (Otgaar, Sauerland, & Petrila, 2013).

In the legal arena, eyewitness misidentification has been shown to be the largest contributing factor leading to wrongful convictions; in the United States, it has played a role in more than 70% (*n* =243) of convictions, which were later overturned as a result of DNA testing (data achieved from the Innocent Project, http://www.innocenceproject.org/causes/eyewitness-misidentification/). Such comprehensive data in relation to wrong judgments are non-existent in China. The main purpose of this review is to assemble the most recent findings on false memories and eyewitness testimony. Firstly, the issue of whether eyewitness testimony has attracted the attention of scholars and legal professionals in China is explored. Subsequently, classical research paradigms that demonstrate the malleability of memory are examined. Thereafter, the latest findings in the field of eyewitness false memory, which have mainly been published in English journals, are considered. Finally, the conclusions and implications for legal practice in China are discussed.

**Eyewitness testimony in Chinese cases**

The judicial system in China adheres to the civil law system or the continental legal system, which is similar to those of most European countries. Judges are the trier of facts and they make judgments based on evidence and the law. Eyewitness testimony is listed as one of the main categories of evidence (Article 42, The Criminal Procedure Law of China). In many historical cases such as those noted in the introduction of this review, eyewitness testimony was assigned particular weight among all kinds of evidence, even when it was contradicted by forensic evidence. Furthermore, eyewitness testimony could be the sole evidence used to convict a suspect; thus, wrongful convictions when eyewitness’ statements were not reliable were possible.

Chen (2007) reviewed 20 nationally-known wrongly convicted cases that were exposed by the media and concluded that torture, the collection of improper evidence and ignoring the use of scientific techniques were the most frequently mentioned risk factors in these cases. One limitation of this review is that the cases described by Chen were “famous” cases that had been exposed by journalists who were particularly interested in uncovering cases involving torture. However, no attention was given to the possibility that erroneous memories might have been present in these cases.

To the best of the researchers’ knowledge, very few studies have focused on the important role that erroneous eyewitness testimonies and accordingly, false memories might have played in legal proceedings in China. To examine this issue more closely, the China National Knowledge Infrastructure (CNKI) Database, which covers 10,267 Chinese academic journals, that is, almost all the academic journals in China, and the CNKI Masters’ Theses Database and Doctoral Dissertations Database were employed to search for literature on false memories and eyewitness testimony at the time of writing this review. The following keywords were selected to search for the relevant literature: eyewitness, eyewitness testimony, eyewitness memory, false memory, eyewitness events, children witnesses, and memory distortions. The literature search yielded 18 papers and six theses/dissertations on eyewitness memory, seven papers on eyewitness identification and nine papers on child witnesses, dated from 1991 to 2016. A review of the literature showed that none of the papers specifically examined the relationship between legal cases and false memories. This suggests that in the Chinese psychological literature, the topic of false memories in the courtroom has not attracted much attention. However, from an examination of many cases in other countries, it is apparent that false memories are an important source of wrongful convictions (Garrett, 2011; Loftus, 2013). Based on this observation as well as the Chinese cases reviewed previously, it is possible that false memories might have also affected the testimonies in Chinese cases.

**The fallibility of memory**

The idea that memory can be easily distorted has been examined by relying on false memory paradigms in which false memories are produced suggestively or spontaneously. Loftus (1975) first demonstrated how leading questions could have an effect on eyewitness reports by employing the *misinformation paradigm*. The misinformation paradigm consists of three stages. In the first stage, the encoding phase, participants generally view a video that depicts an event such as a crime or an accident. Secondly, participants are exposed to misleading information, for example, in the form of statements or leading questions. Finally, in the memory retrieval phase, participants are asked to recall details from the witnessed event. In a pioneering experiment, Loftus (1975) tested 40 college students who watched a three-minute videotape that illustrated eight demonstrators disrupting a class before leaving the classroom. After watching the videotape, half of the participants received subtle misinformation in that they were asked a misleading question, namely, if the leader of the four demonstrators was a male. The other participants were asked if the leader of the 12 demonstrators was a male. One week later, all the participants were asked about the number of demonstrators in the videotape. On average, the first group falsely recalled two more demonstrators than the second group (average 8.85 compared to 6.4).

According to the misinformation paradigm, false memories are caused by external misleading information; this is termed *exogenous false memories*. These false memories have been found in all age groups, from infants to older people in more than 40 years of investigation (Frenda, Nichols, & Loftus, 2011; Loftus, 2005). The misinformation paradigm focuses on the false memories of the details of an event. However, rich false memories of a wholly novel event can also be created by employing suggestive pressure. For instance, in the *false memory implantation paradigm,* participants are presented with fake evidence that depicts a false event such as an old family picture, which has been photo-shopped, and then they are interviewed to elaborate on the false event. Otgaar, Candel, Merckelbach, and Wade (2009) presented children with a fake newspaper article about people who were abducted by an UFO in their hometown when they were four years of age. Each of the participants was then told that his or her mother had confirmed that he or she had been abducted by the UFO as well. Subsequently, each participant was interviewed twice during a period of seven days and asked to recall the UFO abduction. The majority of the children, namely, over 70% vividly and falsely recalled that they had been abducted by aliens. One child, for example, remembered seeing flashes, blue/green puppets and other abducted children in the UFO.

**Exogenous false memories**

**Misinformation during Interviews and Interrogations**

External misleading information can be both verbal and nonverbal. During police interviews and interrogations, the phrasing of the questions as well as gestures made by the interviewers might undermine the accuracy of witnesses’ memories. In one research line that examined the possible effects of different types of questions (Kebbell, Evans, & Johnson, 2010; Kebbell & Johnson, 2000; Kebbell & Giles, 2000), the participants watched a short video of a crime such as a woman being attacked by a man; one week later, they were asked questions about the crime to which they had to either answer yes or no. The researchers found that negative questions (e.g., “Did the woman not have black hair?”), double negative questions (e.g., “Is it not true that the woman did not have black hair?”) and leading questions (e.g., It is true to say that the attack happened in the park, isn’t it?”) resulted in less accurate eyewitness memories in comparison to simpler questions (e.g., “Is it true to say that the attack happened in the park?”). “

Sharman and Powell (2012) compared witnesses’ susceptibility to misinformation across various phrasing structures of the interview questions. Participants went through a typical three-stage misinformation procedure, which comprised witnessing an event, receiving misinformation, and answering memory questions. They were specifically misinformed that there was an AJ’s logo on the perpetrator’s van when in fact there was an RJ’s logo in the film. The participants were asked different types of questions that contained misleading information. Of relevance were the closed specific questions that required a yes or no response and that contained specific misleading details (e.g., “Did Eric have an AJ’s logo in large black letters on his van?”) and the open presumptive questions that suggested certain (misleading) information was true (e.g., “Tell me more about the AJ’s logo on Eric’s van.”). The results revealed that these two types of questions resulted in the highest false memory rates (38%) for misinformation and the least accurate memories for correct details.

Nonverbal misinformation such as gestures during interviews can also lead to eyewitness memory distortions; this has recently been termed the *gestural misinformation effect* (Gurney, Pine, & Wiseman, 2013). In Gurney et al.’s (2013) study, the participants watched footage of a crime scene and were later questioned by an experimenter who acted as a police interviewer. During the interview, no verbal misinformation was given, but when the participants were asked if they noticed any jewelry, the interviewer either suggested a ring by pointing to a finger of the opposite hand or a watch by grasping his or her wrist. The researchers found that more participants (30%) erroneously reported seeing a watch when a watch was suggested than when a ring was suggested (5%). Furthermore, most of the participants (95%) reported seeing a ring when a ring was suggested. In a similar study, it was found that participants who saw the interviewer nod his or her head reported higher confidence in their eyewitness reports than those who saw the interviewer shake his or her head (Gurney, Vekaria, & Howlett, 2014).

More recently, Gurney, Ellis and Vardon-Hynard (2016) examined whether subjective estimates of the nature and severity of the crime could be altered by misleading nonverbal information. The participants were shown a video of a man punching another man in an alleyway and were then interviewed as eyewitnesses. The researchers showed that a punching gesture resulted in participants recalling the crime more accurately. However, a stabbing gesture resulted in more participants (61%) recalling that the victim was stabbed and severely injured compared with the punching condition (5.6%). The researchers also noted that gestural misinformation had the same and sometimes even a larger memory contaminating effect than verbal misinformation.

**Misinformation concerning eyewitness identification**

Misinformation can directly lead eyewitnesses to misidentify innocent people in a lineup. For example, Searcy, Bartlett and Memon (2000) got participants to watch a recording of an actual crime; the murder of an attendant at a dry cleaning outlet. Fifteen minutes later, the participants had to listen to several narratives in which the witnessed crime was described. One narrative included misleading information about the perpetrator having a chipped tooth while in fact the perpetrator did not have a chipped tooth. Some hours later, the participants were asked to identify the culprit in a lineup that comprised photographs of several suspects. Results showed that the participants who received the misinformation were more likely to choose a person with a chipped tooth (25%) compared to those who did not receive the misinformation (6%).

Not only does pre-identification misinformation, that is, information provided before eyewitnesses make identifications from a lineup undermine the accuracy of eyewitness memory, but feedback after the eyewitness identification may distort eyewitness memory. In studies examining how post-identification feedback affects witnesses’ memory reports (e.g., Erickson, Lampinen, Wooten, Wetmore, & Neuschatz, 2016; Skagerberg & Wright, 2009; Smalarz & Wells, 2014; Wells, Olson, & Charman, 2003), participants were provided with either confirming feedback (e.g., “Good, you identified the suspect”) or no feedback after they had identified a suspect from the lineup. The typical finding in these studies was that confirming feedback elevated participants’ confidence in their memories and accordingly, they were more willing to testify in court compared to those in the no feedback condition. Obviously, this inflation of confidence may become a serious issue when the suspect is innocent.

Steblay, Wells and Douglass (2014) conducted a meta-analysis of the post-identification effect based on the data of 21 studies that involved 7,000 participants from the United States, Canada, Europe, and Australia. They found that when an innocent person was chosen from a lineup, confirming feedback increased witnesses’ memory clarity of the culprit, memory of the culprit’s facial details and their certainty in their (false) memories. The effect sizes of the post-identification effect on memory clarity and memory for facial details were medium to large in the reviewed studies (mean Cohen’s *d* of 0.69 and 0.65, respectively).

Many studies on post-identification effects have been conducted in the artificial environment of a laboratory. However, Wright and Skagerberg (2007) tested whether eyewitnesses, both victims and bystanders, of real crimes would change their responses to meta-memory questions after receiving feedback from the police. The researchers evaluated actual eyewitnesses in the United Kingdom and observed that after police officers had told the witnesses that they had identified the true culprit, witnesses claimed better memories for faces and events compared to those who had been told by the police that they had not identified the true culprit.

**Misinformation from co-witnesses**

Crimes often involve multiple witnesses and accordingly, discussions among co-witnesses are common. In September 2003, a famous Swedish politician, Ann Lindh was murdered in a shopping mall. Witnesses discussed and influenced each other while they were kept in a room to the extent that the police collected erroneous information about the identity of the perpetrator. The perpetrator was finally caught on the basis of DNA traces; however, he did not match the descriptions given by the witnesses.[[3]](#footnote-4) Skagerberg and Wright (2008) studied the frequency of co-witness discussions at a United Kingdom identification suite. They found that 88% of the sampled eyewitnesses reported having seen co-witnesses at the crime scene and of these, 58% discussed the crime with their co-witnesses including details of the crime and suspect. This suggests that during such discussions memory errors can easily be formed.

Indeed, discussions with co-witnesses can be a source of misinformation and thus, may influence witness’ memory reports; this phenomenon has been referred to as memory conformity (for possible mechanisms, see Wright, Memon, Skagerberg, & Gabbert, 2009). Gabbert, Memon and Allan (2003) first employed a novel procedure where pairs of participants watched a different video of the same event; they were later encouraged to discuss the event with each other. The large majority (71%) of witnesses falsely recalled items acquired during the discussion with other co-witnesses. Witnesses who initiated the discussion were most likely to have an effect on the other witness’ memories (Gabbert, Memon, & Wright, 2006). Furthermore, misinformation from familiar people such as a friend or a romantic partner has been shown to be more likely to be accepted than misinformation from a stranger (Hope, Ost, Gabbert, Healey, & Lenton, 2008). Recent research has revealed that memory conformity is apparent in both children and adults (e.g., Otgaar, Howe, Brackmann, & van Helvoort, 2017).

Co-witness discussions can also lead to eyewitness misidentification. Zajac and Henderson (2009) examined the impact of co-witness misinformation on lineup identification. Two witnesses watched a video of a theft together and one witness (the confederate) falsely told the other that the thief had blue eyes when in fact the thief’s eyes were brown. The researchers found that witnesses who were misinformed by their co-witnesses were twice (47.2%) as likely to identify a blue-eyed suspect as those who were not misinformed (23.6%). Eisen, Gabbert, Ying and Williams (2017) got co-witnesses to misinform witnesses that the perpetrator had a tattoo on his neck. They manipulated the retention interval between receiving the misinformation and lineup identification. They found that wrongful identifications of the tattooed person increased significantly when retention intervals were longer. After a one-week delay, more witnesses chose the innocent person with a tattoo (44%) than those who chose the true culprit (34%). Even when the co-witness seemed unreliable, for example, by consuming alcohol, witnesses still accepted their co-witness’s misinformation and made incorrect identifications (Zajac, Dickson, Munn, & O’Neill, 2016).

**Endogenous false memories**

Apart from external misleading information, internal cognitive mechanisms may result in the generation of false memories. The *Deese/Roediger-McDermott (DRM) paradigm (DRM)* (Deese, 1959; Roediger & McDermott, 1995) is typically employed to examine endogenous false memories. In the DRM paradigm, participants are shown lists of associated words such as bed, rest and awake, and later asked to recall/recognize which words were shown to them. Participants usually remember non-presented but related critical luring words such as sleep with a great deal of confidence as the words they had seen. Furthermore, they often falsely recollect these critical lures with rates that are indistinguishable from true memory rates (Roediger & McDermott, 1995). The false memory effect in the DRM paradigm has been shown to be a robust phenomenon in children and adults (Howe, 2005, 2006) by employing various stimuli (Hege & Dodson, 2004; Schacter, Israel, & Racine, 1999).

This type of memory illusion is referred to as endogenous; the theoretical explanation is that these illusions are caused by an automatic spreading activation of mental representations (Howe, Wimmer, Gagnon, & Plumpton, 2009; Roediger, Balota, & Watson, 2001). In other words, when witnesses view various items, related but not presented concepts will automatically be activated and this might generate false memories of non-presented items. For example, Otgaar, Howe, Brackmann and Smeets (2016) showed participants a video about a robbery in which a culprit entered the cafeteria and demanded money from the people at the cash desk. Associated items such as money, a cashier, black jacket, masked hat, and robber were shown in the video. However, without any misinformation, the participants automatically formed a false memory; they recalled a gun in the video.

**Emotion and false memory**

Emotions are an important factor that drives endogenous false memories. This is of importance from a forensic perspective because people generally experience intense and/or negative emotions when they experience a crime. Research has shown that 90% of participants formed false memories of negative public events such as the 911 terrorist attack, but only 41.7% of participants had false memories of positive public events (Porter, Taylor, & ten Brinke, 2008). Studies that have examined the effect of emotion on the production of spontaneous false memories have presented participants with different emotionally-laden lists that included both negative and positive words. Subsequently, participants’ susceptibility in forming false memories have been examined. In general, studies have found that false recognition rates for negative DRM lists are higher than for positive or neutral DRM lists (Brainerd, Holliday, Reyna, Yang, & Toglia, 2010; Brainerd, Stein, Silveira, Rohenkohl, & Reyna, 2008; Howe, Candel, Otgaar, Malone, & Wimmer, 2010).

A crime scene may not only elicit emotions such as fear and anger that have a negative valence, but often also induce high arousal. Brainerd et al. (2010) manipulated both the valence and arousal of DRM lists. They found that negative emotions generated higher false memory rates than positive emotions. Furthermore, high arousal generated higher false memory rates than low arousal. Bookbinder and Brainerd (2017) administered negative, neutral, and positive pictures to participants while controlling the arousal level of the pictures. Negative pictures such as negative words enhanced false memory in both immediate and one-week delay recognition tests. On the basis of the studies summarized in this section, one can conclude that emotions that have a negative valence and high arousal enhance the generation of false memories (Bookbinder & Brainerd, 2016; Kaplan, Van Damme, Levine, & Loftus, 2016).

**Stress and false memory**

As negative emotional material encourages false memory formation, one might expect that stress, which is often experienced as negative, promotes false memory too. However, studies that have examined the effects of stress on false memory have found mixed results. Payne, Nadel, Allen, Thomas and Jacobs (2002) were the first to examine the effect of stress on the generation of false memory. In their study, participants were asked to give a speech so as to induce moderate psycho-social stress. Later, the participants listened to DRM lists and then completed a recognition test. The results revealed that stress increased false memory rates when compared to the no-stress condition.

However, this pattern has not been replicated in other studies. Smeets, Jelicic and Merckelbach (2006), for example, followed a similar procedure to that followed by Payne et al. (2002): a stress induction phase, a DRM study phase, and a memory test phase. They also collected participants’ cortisol levels, which is a biological indicator of stress, several times in the experiment so as to check the stress induction manipulation. In the two studies, the researchers did not find any evidence that stress increased false memory production. Furthermore, Smeets, Otgaar, Candel and Wolf (2008) exposed participants to the cold pressor stress task in which participants have to immerse their arm in ice-cold water for as long as possible. Again, there was no indication that false memory proneness was affected by levels of stress.

It is apparent that stress does not increase endogenous false memories, but it might impair true memories for peripheral details, making witnesses highly susceptible to misinformation, that is, creating exogenous false memories (Kaplan et al., 2016). Morgan, Southwick, Steffian, Hazlett and Loftus (2013) examined over 800 military personnel’s false memories of highly stressful events. The participants underwent a highly stressful interrogation in which they were treated as a mock prisoner of war and assaulted physically. Following the stressful event, they completed a misinformation questionnaire in which their memories of the aggressive interrogator were assessed. Approximately half of the participants who had received the misinformation identified the wrong individual as their interrogator.

**Prevention and identification of false memories**

**Preventing false memory and promoting accurate memory**

As noted throughout this review, false memories can easily be generated. However, researchers have also devised several ways to prevent the occurrence of false memories and promote the retrieval of accurate memories. A general principle is to avoid giving suggestive information to witnesses during investigative interviews. An important step in this respect is the construction of empirically validated interview protocols that maximize accurate reporting and minimize false reports. The Cognitive Interview (CI) is a well-studied interviewing protocol that has been employed for interviewing witnesses and studied for more than 30 years. The CI consists of several cognitive principles that may enhance accurate statements. The procedure that eyewitnesses undergo during the CI is thus described (for details see Fisher & Schreiber, 2007). Firstly, the interview is conducted in a friendly manner so as to build rapport with the witness; this is expected to lower the stress that a witness may experience when he or she encounters a police investigator. Research has demonstrated that rapport-building during CI decreases a witness’ susceptibility to misinformation during a mock-crime (Vallano & Compo, 2011). Thereafter, the witness is encouraged to report everything he or she recalled, without being interrupted by the interviewer. Accordingly, the witness controls the flow of information instead of being led by the interviewer. Following this free-narrative phase, the interviewer probes the witness about the target event with open-ended questions, which as noted above, results in fewer false memories than closed questions. Memon, Meissner and Fraser (2010) reviewed 25 years’ laboratory and field studies on the CI, and found that it has resulted in a large and significant increase in correct details with only a small increase in errors in comparison to standard interviewing conditions.

Secondly, post-warnings have been found to be effective in reducing false memories that are caused by misinformation. Post-warnings are warnings given to witnesses in which they are told that some of the post-event information they received might be inaccurate. For instance, Paterson, Kemp and McIntrye (2012) found that participants who had received misinformation from their co-witnesses and warned later that their co-witnesses might have watched a different video reflected on their own memories. Blank and Launay (2014) conducted a meta-analysis of 25 studies from the 1980s to 2010s on the effect of post-warnings. They found that post-warnings can reduce the original memory misinformation effect to 43% of its original (no-warning) size.

Thirdly, using a blind lineup administration can prevent witnesses’ memories from distortion during lineup identification. In a blind lineup, the administrator of the lineup is unaware of the identity of the suspect. A blind lineup can prevent the administrator from giving a witness subtle hints such as an unconscious gesture. Thus, in a blind procedure, it is unlikely that the administrator will intentionally or unintentionally cause the witness to identify a person on the basis of misinformation than during a non-blind lineup. Blind lineup administration can also reduce the post-identification effect such that witnesses’ confidence and judgments about their identifications do not escalate because of erroneous feedback (Dysart, Lawson, & Rainey, 2012).

**Distinguishing between true versus false memories**

It has been reported that false memories contain fewer sensory details than true memories (e.g., Norman & Schacter, 1997). However, in many cases, false memories have been experienced as vividly as true memories (Foley, Bays, Foy, & Woodfield, 2015). With the development of brain scanning techniques such as functional magnetic resonance imaging (fMRI), it is possible to identify false from true memories by studying the neural differences between the two. Furthermore, neural correlates of true and false memories have been studied extensively in recent years. Slotnick and Schacter (2004; 2006) identified different activations in the sensory-processing brain areas for true and false memories. Similar to the DRM paradigm, the participants in their studies viewed various shapes in the study phase and then formed false memories for related, but not presented shapes in the test phase. fMRI scanning of the test phase revealed that there was greater activation in the early visual processing regions for true memories (Brodmann area 17, 18) than false memories. Okado, Stark and Loftus (2010) used the misinformation paradigm in which they presented participants with picture stimuli in the study phase and misinformation one day later. They also found that true memories of visual stimuli were preferentially associated with early visual processing areas, which are normally involved in sensory encoding of visual stimuli (see also Atkins & Reuter-Lorenz, 2011).

Other studies have shown that the auditory stimuli of true memories were associated with activation in the auditory sensory processing regions such as the left temporo-parietal cortex (Cabeza et al., 2001; Abe, Okuda, Suzuki, et al, 2008). On the basis of this information, Schacter, Chamberlain, Gaesser and Gerlach (2011) proposed the *sensory reactivation hypothesis*, which maintains that true memories are accompanied by the retrieval of more sensory/perceptual details than false memories. This pattern is manifested in the reactivation of sensory/perceptual encoding brain regions that are engaged during the establishment of true but not false memories. Thus, when people have truly seen or heard target stimuli, the brain areas that were engaged in processing the stimuli such as the early visual cortex will be activated as soon as they attempt to retrieve memories of the targets. False memories lack these types of activations as they have previously not been “seen” or “heard.” The sensory reactivation hypothesis has been supported by recent studies (Dennis, Bowman, & Vandekar, 2012; Dennis, Johnson, & Peterson, 2014).

Furthermore, researchers have explored the unique neural signature that is associated with false memories. In a recent study, Chadwick, Anjum, Kumaran, Schacter, Spiers, and Hassabis (2016) used fMRI to search for a neural code for false memories in the DRM paradigm. They manipulated the semantic overlap between studied items and critical lures from low to high. The computational analysis enabled them to test the neural overlap between DRM items and critical lures that corresponded to the semantic overlap between them. They found that patterns of activity in the temporal pole can predict false memories and that subject-specific temporal pole neural coding can predict individual false memories.

However, researchers are cautious when it comes to applying neuroimaging techniques in a courtroom to identify an individual’s memory as true or false. Firstly, neuroimaging studies conducted in a laboratory normally examine true and false memories for simple stimuli such as words and pictures. In addition, brain activations induced by simple stimuli might be very different from activations of rich events such as a crime (Schacter & Loftus, 2013). Furthermore, although researchers have found neural differences between true and false memories, those differences are based on the summaries of brain activities in a group of participants, thus, making it difficult to apply the results to a single participant (Van de Ven, Otgaar, & Howe, in press). Recently, although studies have shown neural decoding of individual (false) memories (e.g., Chadwick et al., 2016), presently the differentiation between false and true memories is not completely accurate. However, as neuroimaging techniques develop and more complex stimuli are examined, it appears promising that false from true memories will be distinguished at the neural level, particularly because it is almost impossible to distinguish false from true memories at the behavioral level (Bernstein & Loftus, 2009).

**Conclusions and future directions for China**

Two types of false memories, namely, exogenous and endogenous false memories and the possible consequences of both in eyewitness testimony were examined. Exogenous false memories may occur after people receive external misinformation, which can include suggestive questions and gestures during interviews, misleading information in pre- or post-lineup identification and false information from a co-witness. Endogenous false memories are generated by internal cognitive mechanisms without external misleading information, and can be inflated by negative emotions and high arousal. In essence, false memories can result in incorrect descriptions of the perpetrator or the crime, which may result in the investigation pursuing the wrong direction or more directly, cause eyewitnesses to misidentify an innocent person as the perpetrator. Designated interview protocols such as the CI, blind lineup administration, and post-warnings that could prevent or lower the chance of false memory occurrence were explored.

When considering the cases that were presented in the introduction, several factors that are extremely relevant to what has been examined in the rest of the review are prevalent. Haisheng Zhang was not only misidentified by the victim, but also by three other teenage girls who lived in the same village. Being co-witnesses who knew each other well, the girls probably had spoken with each other and eventually reached memory conformity. Furthermore, Zhang’s lawyer presented evidence in the court that the police had told the girls to “look carefully at the shoes” during the lineup identification. This may be regarded as a suggestive hint, which the court appeared to have overlooked and therefore, convicted Zhang as guilty of rape.

In the case of Jibin Xu, the court relied heavily on the statements of the victim witness that Xu was the perpetrator. At Xu’s first trial, he proposed that the victim was lying to imprison him; however, the court was not convinced by this alternative explanation. It is unknown whether the witness was lying or merely had a false memory, but this case is very similar to the many cases archived in the Innocence Project ([www.innocenceproject.org](http://www.innocenceproject.org)) where witnesses had false memories about the perpetrators. If the risk of false memory had been widely acknowledged by practitioners in the legal system at that time, Xu might have avoided the destiny of spending 8 years in prison.

Fortunately, countries in North America and Europe have become acquainted with studies on false memories; these studies might inform police and local courts in China about what is best to protect innocent people from being criminalized by false memories. For instance, in the United States, the supreme court of New Jersey issued a ruling that the unreliability of memory should be taken into account when evaluating eyewitness identification evidence in court (State v. Henderson, 2011). The Criminal Procedure Law of the People’s Republic of China was revised in 2012, in which eyewitness testimony was listed as one of the main categories of evidence (Article 42) and the testimony of a witness may be used as a basis in deciding a case under certain circumstances (Article 47). However, there is no specific rule to regulate eyewitness identification processes such as lineup administration. In practice, the Public Security Organs and the People’s Procuratorate provide provisions that the identification should be determined by investigation or prosecution personnel. Furthermore, 97% of the identifications in China are conducted by the investigators who undertook the case (Chen, 2015). The aforementioned situations may be prone to the risk factors of false memories such as unintentional misinformation and suggestion. It is the opinion of the authors that various steps are needed to increase awareness of the importance of eyewitness testimony and false memories in Chinese legal cases.

It is contended that improving awareness of false memories in the legal arena is possibly the first step in the process. Memories are more prone to errors than many people think. It is especially important for judges, lawyers, and the police to be *aware* of this problem. Knowledge of how memory works and how to prevent false memories can be shared in workshops and seminars (Loftus, 2003). This is important as many legal professionals possess flawed ideas about the functioning of memory, for example, memory can be compared to a video-taping. Firstly, legal professionals such as the police need to be educated about the science of memory and its relevance to courts of law. Such interventions might assist legal professionals to get rid of their biases regarding the functioning of memory (Lilienfeld, Ammirati, & Landfield, 2009). Secondly, there should be close collaboration with legal professionals. Furthermore, endeavors to launch various actions in investigative and juridical processes to *prevent* false memories such as the use of empirically-validated interview protocols and blind lineup identification as well as launching new laws and regulations on organization and the administration of eyewitness identification should be introduced. Such actions have already taken place in countries such as the United Kingdom and the Netherlands.

Finally, other measures can be employed such as actively *recognizing* the possibility of the occurrence of false memory occurrence in legal practice. An ideal route to accomplish this is for triers of fact to consult memory experts in legal cases more often. In many countries, expert witnesses who are memory researchers as well are called upon to provide their expert opinion concerning a memory-related issue in a case such as the disclosure of a child’s statements on sexual abuse (Otgaar & Howe, in press). Such experts might considerably assist judges and lawyers in such and might help judges reach legal decisions that are grounded in memory science. For instance, Wise and Safer (2012) designed a toolkit to analyze the trustworthiness of eyewitness testimony by evaluating the risky factors step-by-step, which has been examined in this article.

The rapid urbanization in China has made this issue even more urgent and challenging. According to data from the National Bureau of Statistics of China[[4]](#footnote-5), until 2016, there were 156 cities in China with populations of more than one million. Furthermore, 13 cities had populations of over ten million. Up until 2016, there were 792 million people who inhabited cities with different scales. China has more than 50 ethnic groups who have different cultures and religions such as Uygur, Tibet, and Mongolian. Misinformation and stereotypes of people from different ethnicities and backgrounds may boost the malleability of memory that may result in wrong convictions. Criminal proceedings are to a large extent dependent on what eyewitnesses report. Nevertheless, it is not the intention of this review to leave the impression that eyewitnesses are wrong all the time or even most of the time. Eyewitnesses may often be impressively accurate and in many cases, eyewitnesses contribute critically to fair and just legal proceedings. The authors’ review of the literature is an attempt to further increase the trust that triers of fact can place in eyewitnesses by excluding conditions that promote false memories.

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