REVIEW ARTICLE

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 contributing to miscarriages of justice in the United States. To date, no study has focused on how false memories might 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 some light on how the Chinese legal system may incorporate these experiences into practice. Overall, false memories of eyewitnesses are generated either by external misleading information or by internal cognitive processes; false memories may guide police investigations in the wrong direction or cause eyewitnesses to misidentify an innocent person as the perpetrator. We conclude that specially 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.

Somewhere in December, 2003, Haisheng Zhang (张海生) was visiting his relatives in Lichuang County, Henan Province, China. Suddenly, he was detained 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, three teenage girls identified Zhang from a lineup as the person who talked to the victim and led the victim to the woods. Meanwhile, there was no physical evidence to incriminate Zhang as the offender. More than a

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[1] http://news.sina.com.cn/c/2005-04-14/04075642673s.shtml

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]

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 as well. In this case,

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Jibin Xu (徐继彬) was wrongfully convicted of rape because he was identified by the victim as the assailant, even though the police should have found out that his blood type did not match the blood type of the real perpetrator. Only after 16 years, he was proven innocent by a blood test.[2]

In these cases, innocent people were convicted because of the absolute reliance on eyewitness testimonies even when they included erroneous memories implying someone's guilt. In the absence of physical evidence, these testimonies became crucial. Importantly, in the majority of criminal proceedings, eyewitness testimonies are the most important piece of evidence (e.g., Howe, Knott, & Conway, 2018). Objective evidence such as DNA evidence is frequently lacking (Howe & Knott, 2015; Peterson, Hickman, Strom, & Johnson, 2013). Consequently, often legal professionals have to rely on the memory of a victim and/or witness. However, memory is a flexible system that is not as reliable as people expect (Loftus, 2004; Schacter, 2012). Our memories are fallible. That is, they are not literally reproduced but reconstructed when they are retrieved (e.g., Howe et al., 2018). During such reconstruction, unintentional errors might slip in, which can lead to the occurrence of false memories. False memories refer to memories of events that did not happen, yet are experienced as real (Loftus, 2005). Although such false memories can occur in many different situations (e.g., misremembering that you placed your car keys on the table while in fact they were still in the car) and are oftentimes relatively innocuous, when they enter the legal arena, consequences can be quite dramatic especially when they 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, playing a role in more than 70% (*n* =243) of convictions which were later overturned through DNA testing in the United States (data achieved from the Innocent Project, http://www.innocenceproject.org/causes/eyewitness-misidentification/). Such comprehensive data are non-existent in China regarding the

reasons for miscarriages of justice. The main purpose of this review is to assemble the most recent findings on false memories and eyewitness testimony. First, we will review whether the issue of eyewitness testimony has attracted the attention of scholars and legal professionals in China. Next, we will discuss classical research paradigms that demonstrate the malleability of memory. Following this, we will concentrate on the latest findings in the field of eyewitness false memory, which have mainly been published in English journals. Finally, 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, which leaves possibilities for wrongful convictions when eyewitness' statements were not reliable.

Chen (2007) reviewed 20 nationally-known wrongly convicted cases that were exposed by the media and concluded that torture, improper evidence collection, 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 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 our knowledge, very few studies have focused on the important role that erroneous

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[2] http://news.sina.com.cn/c/2007-03-20/120311454076s.shtml

eyewitness testimonies and accordingly, false memories might have played in legal proceedings in China. To examine this issue more closely, we selected 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 to search for literature on false memories and eyewitness testimony at the time of this writing. 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. After reviewing these papers, we found that not one paper specifically looked at 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, although we know from many cases in other countries that false memories are an important source of wrongful convictions (Garrett, 2011; Loftus, 2013). Based on this observation and the Chinese cases reviewed previously, it is likely that false memories might have affected testimonies in Chinese cases as well.

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*. Basically, the misinformation paradigm consists of three stages. In the first stage, the encoding phase, participants generally view a video depicting an event such as a crime or an accident. Then in the misinformation stage, 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 3-min videotape depicting eight demonstrators who disrupted a class before leaving the classroom. After watching the videotape, half of the participants received subtle misinformation by asking them a misleading question: "was the leader of four demonstrators a male?". The other half was asked: "was the leader of the twelve demonstrators a male?". One week later, all the participants were interviewed 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).

In the misinformation paradigm, false memories are caused by external misleading information and we term them *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 false memories for details of an event. Yet, rich false memories of a wholly novel event can also be created using suggestive pressure. For instance, in the *false memory implantation paradigm,* participants are presented with fake evidence depicting a false event (e.g., a photoshopped old family picture) 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 being abducted by a UFO in their hometown when they were aged 4. The child participant was then told that his or her mother had confirmed that he or she had been abducted by the UFO as well. Later, the 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), participants first watched a short video of a crime such as a woman being attacked by a man; one week later, they answered "yes" or "no" to questions about the crime. 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 a park, isn't it?") resulted in less accurate eyewitness memories in comparison to simpler questions (e.g., "Did the attack happen in a park?").

Sharman and Powell (2012) compared witnesses' susceptibility to misinformation across various phrasing structures of the interview questions. Participants went through the typical three-stage misinformation procedure (i.e., witnessing an event, receiving misinformation, and answering memory questions). Specifically, they were 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 containing misleading information. Of relevance here are the closed specific questions that require a yes or no response and contain specific misleading details at the same time (e.g., "Did Eric have an AJ's logo in large black letters on his van?") and the open presumptive questions that suggest certain (misleading) information is 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 the misinformation as well as the least accurate memories for correct details.

Nonverbal misinformation such as gestures during interviews can also lead to eyewitness memory distortions, which has recently been termed the *gestural misinformation effect* (Gurney, Pine, & Wiseman, 2013). In Gurney et al.'s (2013) study, 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 "Did you notice any jewellery?", the interviewer made either a gesture of a ring by pointing to a

finger of the opposing hand or a gesture of a watch by grasping his 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 gesture was made. 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) had participants look at a recording of an actual crime, the murder of an attendant at a dry cleaner's. Fifteen minutes later, participants had to listen to several narratives in which the witnessed crime was described. One narrative included misleading information that the perpetrator had a chipped tooth while in fact the perpetrator did not have a chipped tooth. Some hours later, participants were asked to identify the culprit in a lineup consisting of 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 also 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 are provided with either confirming feedback (e.g., "Good, you identified the suspect") or no feedback after they identified a suspect from the lineup. The typical finding in these studies is that confirming feedback elevates participants' confidence in their memories and they are more willing to testify in court compared to those in the no feedback condition. Obviously, this confidence inflation can 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 data of 21 studies involving 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 authors 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, such that the police collected errneuous 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] 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 the 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 impact 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 lead to eyewitness misidentification as well. Zajac and Henderson (2009) examined the impact of co-witness misinformation on lineup identification. Two witnesses watched a video of a theft together and

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https://en.wikipedia.org/wiki/Memory_conformity

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) had witnesses misinformed by co-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, there were more witnesses who chose the innocent person with a tattoo (44%) than those who chose the true culprit (34%). Even when the co-witness seemed unreliable (e.g., consumed alcohol), witnesses still accepted their co-witness's misinformation and made wrongful 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* (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 lure words such as sleep as the words they had seen with very high confidence. 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), using different stimuli (Hege & Dodson, 2004; Schacter, Israel, & Racine, 1999).

We term this type of memory illusions "endogenous" as the theoretical idea is that these illusions are caused by 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, cashier, black jacket, masked hat, and robber were shown in the video. However, without any misinformation, participants automatically formed a false memory for the presence of a gun in the video.

Emotion and False Memory

Emotion is one 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 the participants formed false memories of negative public events such as the 911 terrorist attack, but only 41.7% of the 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 (negative, positive) and then examine participants' susceptibility in forming false memories. 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 emotion generated higher false memory rates than positive emotion and 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 both 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 fuels false memory formation, one might expect that stress – which is often experienced as negative – promotes false memory too. However, studies examining 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 false memory creation. In their study, participants were asked to give a speech so as to induce moderate psycho-social stress. Later, 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 two studies, the authors 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 seems that stress does not increase endogenous false memories, but it might impair true memories for peripheral details so that it makes 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 for highly stressful events. Participants went through a highly stressful interrogation in which they were treated as a mock prisoner of war and assaulted physically. Following the

stressful event, a misinformation questionnaire was introduced and later participants' memories for 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

The story so far is that false memories can be easily 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. One important step here is the construction of empirically validated interview protocols that maximize accurate reporting and minimize false reports. One well-studied interview protocol is the Cognitive Interview (CI). The 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. During the CI, eyewitnesses undergo the following procedure (for details see Fisher & Schreiber, 2007). First, the interview starts in a friendly manner to build rapport with the witness, which will 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 for a mock-crime (Vallano & Compo, 2011). Thereafter, the witness is encouraged to report everything 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.

Second, post-warnings have been found to be effective in reducing false memories that are caused by misinformation. Post-warnings are warnings given to participants that some of the post-event information they received might be inaccurate. For instance, participants who had received misinformation from their co-witnesses were warned later that their co-witnesses might have watched a different video, thus making the participants to reflect on their own memories (Paterson, Kemp, & Mclntyre, 2012). 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.

Third, using a blind lineup administration can prevent witnesses' memories from distortion during lineup identification. In a blind lineup administration, 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 lead 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 due to erroneous feedback (Dysart, Lawson, & Rainey, 2012).

Distinguishing between True versus False memories
False memories have been reported to contain fewer sensory details than true memories (e.g., Norman & Schacter, 1997), but there are also many cases where false memories are experienced as vividly like 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, 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. Fisher, 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 true memories for auditory stimuli 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 type of results, Schacter, Chamberlain, Gaesser, and Gerlach (2012) proposed the *sensory reactivation hypothesis*, which holds 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 were engaged during the establishment of true but not false memories. Thus, when people have truly seen or heard target stimuli, brain areas that were engaged in processing the stimuli (e.g., early visual cortex) will be activated as soon as they attempt to retrieve memories of the targets. False memories lack such kind of activations as they have not been "seen" or "heard" before. 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 the courtroom to identify an individual's memory as true or false. First, neuroimaging studies conducted in the lab normally examine true and false memories for simple stimuli such as words and pictures, and brain activations induced by simple stimuli might be very different from activations of rich events such as a crime (Schacter & Loftus, 2013). What's more, 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 there are studies showing neural decoding of individual (false) memories (e.g., Chadwick et al., 2016), but the differentiation between false and true memories is at present far from 100% accurate. Still, 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

We reviewed two types of false memories (exogenous vs. endogenous) and their possible consequences in eyewitness testimony. Exogenous false memories may occur after people receive external misinformation, which can be suggestive questions or gestures during interviews, misleading information pre- or post-lineup identification, or 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 emotion and high arousal. Overall, false memories can result in incorrect descriptions of the perpetrator or the crime that may guide the investigation into a wrong direction, or more directly, cause eyewitnesses to misidentify an innocent person as the perpetrator. We also reviewed that designated interview protocols such as the CI, blind lineup administration, and post-warnings could prevent or lower the chance of false memory occurrence.

In returning now to the cases that were presented at the beginning, we may find several factors very relevant to what we have reviewed here. For example, 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, which might be regarded as a suggestive hint, but the court appeared to have overlooked this and 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, yet 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) 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, lessons have already been learnt by countries in North America and Europe, and those lessons might inform police and local courts in China about what are the 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 has been revised in 2012, in which eyewitness testimony is 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), but no specific rule is written in regulating 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 hosted by investigation or prosecution personnel, and 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. In our opinion, several steps are needed to increase awareness concerning the importance of eyewitness testimony and false memories in Chinese legal cases.

We contend that improving awareness of false memories in the legal arena is perhaps the first step to start. Memories are more prone to errors than many people think. It is especially important for judges, lawyers, and the police to be *aware* of that. Knowledge of how memory works and how to prevent false memories can be shared in ways of 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. A first direction could be to educate legal professionals such as the police about the science of memory and its relevance to courts of law. Such interventions might help legal professionals to get rid of their biases regarding the functioning of memory (Lilienfeld, Ammirati, & Landfield, 2009). A second important follow-up step would be to collaborate closely with legal professionals and attempt 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. Such actions have already taken place in countries such as the United Kingdom and the Netherlands.

Finally, other measures can be taken by actively *recognizing* the possibility of the occurrence of false memory 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 that we have reviewed above.

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], 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 in total who inhabited cities with different scales. China has more than 50 ethnic groups with 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, since 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 attain impressive accuracy and in many cases, eyewitnesses contribute critically to fair and just legal proceedings. Our 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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Declaration of Conflicting Interests

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[4] http://data.stats.gov.cn/easyquery.htm?cn=C01&zb=A0B01&sj=2016

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