Self-reference Enhances Susceptibility to False Memory

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Abstract

Eyewitness testimony serves as important evidence in the legal system. Eyewitnesses of a crime can be either the victims themselves—for whom the experience is highly self-referential—or can be bystanders who witness and thus encode the crime in relation to others. There is a gap in past research investigating whether processing information in relation to oneself versus others would later impact people's suggestibility to misleading information. In two experiments (*N*s = 68 and 122) with Dutch and Chinese samples, we assessed whether self-reference of a crime event (i.e., victim versus bystander) affected their susceptibility to false memory creation. Using a misinformation procedure, we photoshopped half of the participants' photographs into a crime slideshow so that they saw themselves as victims of a non-violent crime, while others watched the slideshow as mock bystander witnesses. In both experiments, participants displayed a self-enhanced suggestibility effect: Participants who viewed themselves as victims created more false memories after receiving misinformation than those who witnessed the same crime as bystanders. These findings suggest that self-reference might constitute a hitherto new risk factor in the formation of false memories when evaluating eyewitness memory reports.

Keywords: Self, False Memory, Misinformation, Victim, Bystander

Self-reference Enhances Susceptibility to False Memory

One of the most controversial issues in the legal system is the occurrence of miscarriages of justice. Data from the Innocence Project in the US tell us that wrongful convictions are caused by eyewitness misidentification in about 69% of exoneration cases (Innocence Project, 2022). Witnesses might identify an innocent person as the perpetrator when their memories of an event have been affected (e.g., as a result of suggestive police interviewing, bad lightning conditions, time). Eyewitness testimony plays a major role in legal decision making because objective evidence is often lacking (Howe & Knott, 2015). Therefore, it is crucial to understand under what circumstances memories are prone to errors.

Past research has found that people's memories can be distorted when confronted with suggestive questions leading to false memories, termed as the misinformation effect (Loftus, 2005). For example, one study found that participants misremembered seeing a barn when there was actually no barn when suggestively asked "How fast was the car going when it passed the *barn* while traveling along the country road?" (Loftus, 1975). Or, when participants were misinformed that the perpetrator had blue (while they had in fact brown) eyes, they were more likely to misidentify blue-eyed innocents as the perpetrator (Zajac & Henderson, 2009). Of special interest here, eyewitnesses can be either victims of a crime who experience the crime from a self-referential perspective and thus process information in relation to themselves, or can be bystanders who witness the crime happen to others. The self is a complex set of active goals and associated self-images (Conway, 2005), and presenting cues such as one's own name or own image could serve as an operation to activate the self (Cunningham et al., 2014; Wang et al., 2018, 2022). Encoding information in relation to oneself (e.g., one's own name or image) is well-known for

its effect on shaping memory (Klein, 2012; Symons & Johnson, 1997). However, to our knowledge, no research has looked into the role of self in false memories elicited by misinformation.

Data from real cases imply a potential role of self in eyewitness memory. We analyzed 249 wrongful conviction cases that involved eyewitness misidentifications from the Innocence Project (up until March 2022) to compare the percentage of misidentifications made by victims versus that by bystanders. Table 1 shows that victims made more misidentifications (n = 192, 77.1%) than bystanders (n = 58, 23.3%). Misidentifications can unfold due to a wide variety of reasons, but one important reason is that people can be misled when confronted with suggestive questions leading to false memories (Loftus, 2005). Although the Innocence Project data could be due to a case selection bias (that the database did not include all wrongful convictions), this anecdotal evidence of a possible differential effect of eyewitness role on eyewitness performance suggests great importance of understanding how self-reference (e.g., victim vs. bystander) might affect people's proneness to accepting misleading information.

Table 1. Number of wrongful conviction cases that involved misidentifications by victims and bystanders.

		Misidentification by victims		Total
		Yes	No	
Misidentification by bystanders	Yes	22	36	58 (23.3%)
	No	170	21 (unable to code)	191 (76.7%)
Total		192 (77.1%)	57 (22.9%)	249

Note: For 21 out of the 249 cases archived as involving misidentifications in the Innocence Project, we were unable to classify the origins of the misidentifications based on the case files.

Self-reference and (False) Memory

It is well established that self plays a crucial role in shaping autobiographical memory (Conway, 2005). For example, past research has shown that people remember more words when judging whether the words can describe themselves versus others, termed as the self-reference effect (Kuiper & Rogers, 1979). Research has also found that participants remembered more perceptual details when encoding objects by making judgements in reference to oneself relative to making judgements in reference to others (Leshikar, Dulas, & Duarte, 2015; Serbun, Shih, & Gutchess, 2011). Moreover, when encoding information in relation to oneself, participants not only have better memory of an item (e.g., an apple) but also remember better which items were associated with oneself (e.g., apple with oneself) than when encoding information in relation to others (Cunningham et al., 2014; Wang et al., 2021a).

False memories can be created due to external suggestive information, resulting in suggestive false memory, or they can be generated without external misleading information leading to spontaneous false memories (Brainerd et al., 2008; Wang et al., 2018). Recent research has investigated whether the self can amplify spontaneous false memory rates. Wang and colleagues (2019) combined a self-reference manipulation with a standard false memory paradigm, the Deese-Roediger/McDermott paradigm (DRM; Deese, 1959; Roediger & McDermott, 1995). The DRM paradigm consists of lists of associated words, such as *robber, bullet, bank, mask, and cashier,* and encoding of these words leads to the remembrance of related but non-presented lure items (i.e., *gun*). This memory error is called a spontaneous false memory as no external pressure is involved (Brainerd et al., 2008). Wang and colleagues (2019) presented participants with the DRM words together with their own name (self-reference) or another celebrity's name (other-reference, e.g., Trump,

Adele). Participants' false memories for the lure items were significantly higher in the self-reference condition than in the other-reference condition. Subsequent research also revealed that self-reference facilitated the false binding between the lure items and the self (i.e., participants formed more self-lure associative memories; Wang et al., 2021a). Using the DRM paradigm, this enhancing effect of the self on the production of spontaneous false memories of words has been consistently found in various age groups, including children, younger adults, and older adults (Ozdes et al., 2021; Rosa & Gutchess, 2013; Wang et al., 2022).

One explanation for the finding that the self facilitates both true memory of studied words and false memory of non-studied lures might be that self-referential processing (i.e., encoding information in relation to oneself) assists in the organization of information in relation to oneself by leading participants to think about the stimulus words in relation to one another (see Klein, 2012; Klein & Kihlstrom, 1986; Wang et al., 2019). Via enhancing the organization of information, activation is likely to spread in one's knowledge thereby triggering related nodes referring to presented information. In this way, self-referential processing can promote true memory. For example, people tend to remember *sound* and *piano* better when organizing the words as related to *music*, and self-referential processing could make people better at organizing studied stimuli as related to the self (Klein & Loftus, 1988). As a result, facilitation of organizing information can in turn boost false memory for the non-studied themes (i.e., *music*) that have been used to organize information. Specifically, such organization can lead to levels of associative activation that not only triggers nodes of presented information but also nodes of related but non-presented information. This suggests that the self can enhance true memory but at the cost of increasing false memory for words not presented.

However, research so far has only focused on the effect of self on spontaneous false memories in word lists (i.e., without misinformation). In legal cases, eyewitnesses might receive misinformation about stimuli, which is also much richer than word lists. The misinformation may come from various sources such as the police, the media, and co-witnesses, possibly resulting in false memories related to the crime (Loftus, 2013; Wang et al., 2018). Research has suggested that false memories induced by the DRM paradigm have different mechanisms with false memories induced by external suggestive information (Zhu et al., 2013; Patihis et al., 2018). Understanding how self-reference might impact suggestion-based false memories can clarify whether self-reference might be a potential risk factor for suggestion-based false memory in legal and clinical cases. Furthermore, examining whether relating events to the self can elevate suggestion-based false memory rates could help further uncover the mechanisms underlying the role of self in false memory formation.

A standard procedure to investigate false memories induced by suggestion is the misinformation paradigm. In this paradigm, participants first witness a video or slideshow of a crime, then one group receive misleading information concerning the crime, and finally their memories for the original event are tested (Loftus & Palmer, 1974). Participants in the misled group tend to report more false memories—that the misleading information was part of the original event—compared to the control group. For example, Stark, Okado, and Loftus (2010) presented participants a series of photographs depicting a man stealing a woman's wallet and hiding behind a *door*. Then, participants read a narrative containing misleading information (e.g., the man hid behind a *tree*). Later, when asked where the man hid, more than 40% of the misled participants answered that they had seen him hiding behind a tree.

Two main theoretical accounts exist explaining the mechanisms underlying the misinformation effect. The *destructive updating* account proposes that misinformation replaces the original event thereby "erasing" the original memory (Loftus & Loftus, 1980). Recent research on human memory reconsolidation (i.e., a process that can abolish a previously stable memory and make the memory enter an unstable state) makes this account gain attention again by showing memory impairment for the original event in the misinformation paradigm (e.g., Chan & LaPaglia, 2013). An alternative account stipulates that the original memory is not erased, but simply becomes less accessible. This explanation is bolstered by research showing that the original memory can be retrieved again under certain circumstances (McCloskey & Zaragoza, 1985; Rindal, DeFranco, Rich, & Zaragoza, 2016). Although there is a debate regarding whether the original memory is erased or not, a consensus is that when memories are retrieved they enter an unstable process, and memories are amenable to changes (e.g., misinformation) when memory is reactivated during the misinformation phase (Chan & LaPaglia, 2013; Lee et al., 2017; Rindal et al., 2016). An unresolved issue is what role the self might play in such memory updating process.

According to the mechanisms underlying self and memory, the self can facilitate binding of information in the memory network, including (false) binding between non-presented items and the self (Cunningham et al., 2014; Sui & Humphreys, 2015; Wang et al., 2021a). During the misinformation phase, when people's self-referential memories (e.g., memories from a victim) are activated, the self might facilitate the binding of received misinformation into the original memory episode, thus increasing the chance of reporting misinformation at a final memory test. Indeed, previous research on the test-potentiated learning effect (Chan, Meissner,

& Davis, 2018) has found similar mechanisms that manipulations such as prior retrieval that can promote learning of the misinformation might facilitate eyewitness suggestibility. In our study, when self-processing facilitates learning of misinformation, participants' false memories of misinformation might be increased. For example, when victims are asked "what were you doing when the man with *a red backpack* (misinformation) walked passed you?," they need to retrieve this autobiographical memory episode and the activation of the self might facilitate the incorporation of *red backpack* into memory relative to seeing other-referential information. However, an alternative possibility and contrary to our prediction is that true memory performance of the original crime event may reduce the misinformation effect. That is, the self may help participants remember more details of the crime, and enhanced true memory of the original event might make it easy detect discrepancies with the misleading information, resulting in a reduced misinformation effect in the self-reference condition. The current study could test the above potential mechanisms.

Another theoretical framework that could account for the misinformation effect is the source monitoring framework (Johnson, Hashtroudi, & Lindsay, 1993; Mitchell & Johnson, 2009). According to this account, mental representations can be attributed to various sources, such as perception, memory, imagination and dreams. People keep track of the sources of their mental representations (e.g., which are memories and which are imaginations). Within the misinformation paradigm, once participants mistakenly attribute misinformation received from a later narrative or misleading question as what they previously saw, false memories can occur. Hence, asking participants to judge the source of their answer (e.g., whether an item appeared in the original event or in a narrative) can reduce the likelihood of misattribution, resulting in fewer false memories (Lindsay & Johnson, 1989, Patihis et al., 2013).

Within the source monitoring framework, it is possible that self-reference can enhance the memory strength of the original event, making it easier to reject misinformation when source memory questions are asked than when a simple yes/no recognition question is asked. Another interesting question is how self-reference would impact suggestibility under different levels of source monitoring strength.

The Current Experiments

In two experiments, we assigned participants as mock victims or bystanders in a non-violent crime using the misinformation paradigm in order to examine how self-reference would impact people's susceptibility to misinformation. Participants first watched a slideshow of a man stealing a woman's wallet, then later received misinformation about the event, and finally were tested for their memory of the slideshow. The key manipulation was that half of the participants' images were photoshopped in the slideshow, so they would see themselves as victims of the crime (i.e., the self-reference condition). Other participants watched the exact same crime as a mock bystander (i.e., the other-reference condition), with the victim being a participant from the self-reference condition. Based on previously reviewed findings suggesting a mechanism that self can enhance false binding of information, we predicted that participants in the self-reference condition would produce more false memories than participants in the other-reference condition after exposing to misleading information. Another possibility was that, because the self facilitates true memory for details of the crime, enhanced memory of the original event would make the misinformation less likely to be reported.

Seeing one's own face might attract participant's attention (Humphreys & Sui, 2016) and may lead to overall weaker memory for peripheral details of the crime and thus increase their susceptibility to crime-related misinformation. In both

experiments, we coded details of the crime as central or peripheral and examined how self-referencing would impact false memory rates of central versus peripheral details to further uncover mechanisms underlying the self-reference effect. Moreover, victims in real cases might experience different intensity of negative emotions relative to bystander witnesses, and negative emotion can enhance false memory due to misinformation (Porter et al., 2010; Van Damme & Smets, 2014; Wang et al., 2018). In Experiment 2, we measured participants' emotions after they watched the crime event to examine the role of emotion in the effect of self-reference on false memory.

Experiment 1

Method

Participants

In total, 70 participants were tested in our study. Data of two participants were excluded because of incomplete data, resulting in a final sample of 68 participants for analysis. Participants (19 males, 28%; 49 females, 72%) were university students with a mean age of 24.69 years old, (*SD* = 7.42, range 18-58 years). There were 34 participants (9 males) in the self-reference condition and 34 participants (10 males) in the other-reference condition. A sensitivity power analysis revealed that the study can detect at least an effect size of 0.68 with the current sample size ($\alpha = .05$, two-tailed, $1-\beta = .80$). Participants received course credit for their participation. The study was approved by the ethical committee of the Faculty of Psychology and Neuroscience, Maastricht University. The study was pre-registered in the Open Science Framework (https://osf.io/srygz).

Design

The study manipulated self-reference of a crime in a between-subjects design with two conditions, the self-reference (i.e., victim) condition and the other-reference

(i.e., bystander) condition. In the self-reference condition, participants viewed a slideshow depicting a non-violent crime in which photographs of themselves (taken during the first session of the experiment) were photoshopped into the slides as the victim of the crime. In the other-reference condition, participants viewed the same slides, with the victim—another participant— being an unknown stranger. Participants were randomly assigned to the self- or other-reference condition. Critically, the experiment was controlled in a way that every two participants would view the exact same photoshopped slides, with one of them being the victim. Thus, although these two participants watched the same crime, one of them saw themselves as the victim while the other participant acted as a mock bystander. This was done to make sure that participants in the self-reference and other-reference conditions viewed comparable stimuli. Participants were tested individually in the lab. All participants received the same misinformation narrative afterwards. The dependent variable was their memory on the subsequent memory test.

Materials

Slideshows. The slideshow vignette consisted of 32 color digital slide images that depicted a man stealing a woman's wallet on the street. The images were selected from the materials used in previous research (Okado & Stark, 2005; with slightly modified misinformation narratives taken from Patihis et al., 2013). The images were presented in a slideshow with the speed of 3500 ms per image. Participants would later receive misinformation about six of the 32 slides. We photoshopped photographs of the participants in the Self-reference condition into the slideshows, depicting them as victims of the crime (see Figure. 1).

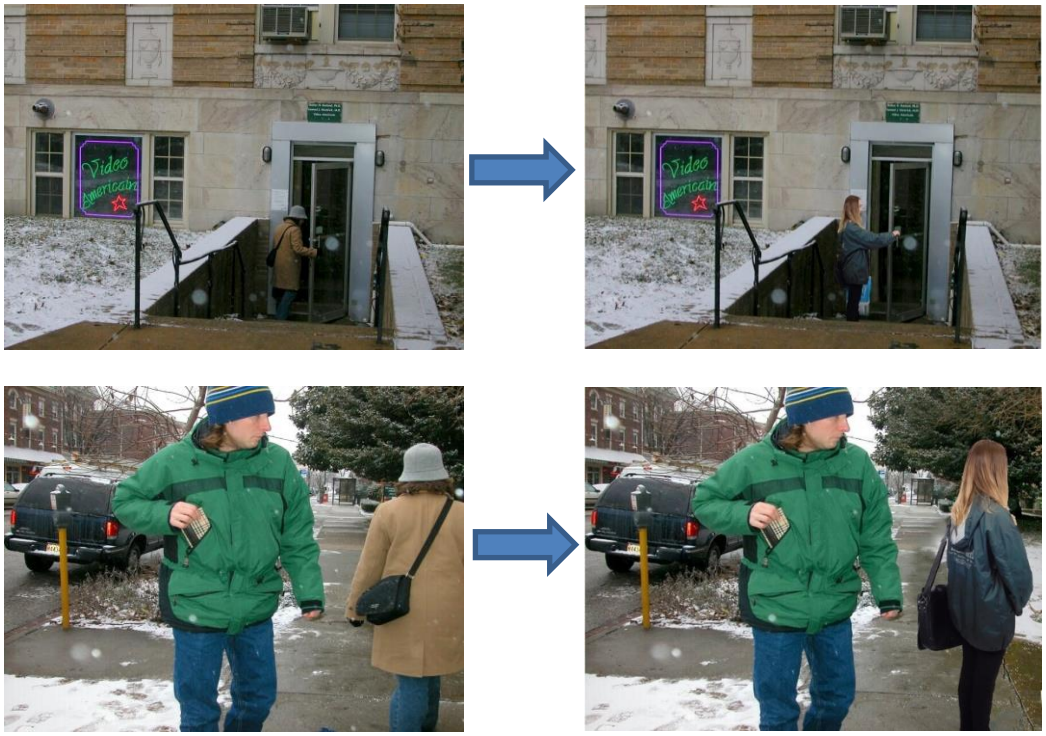

Figure 1. Examples of photoshopped slide images. Every two participants (one from the self-reference condition and one from the other-reference condition) would see the exact same photoshopped slide images that contained the photographs of the participant in the self-reference condition.

Misinformation. Participants received six items of misinformation amongst many true statements in the form of a police narrative. All participants received the same misinformation narratives. Participants read that a police detective had carefully looked at the photographic slides several times, and had then written a narrative about what he saw. The narrative consisted of 32 sentences, each of which described one image in the crime slideshow. Each sentence was presented on screen for 5500 ms. Six sentences contained misleading information (e.g., the man took the wallet and put it into his *pants pocket* while in fact he put the wallet into his Jacket pocket). These misinformation paradigm materials have successfully produced the misinformation effect in previous research (Patihis et al., 2013). Importantly, the narrative mentioned the victim's (i.e., participants') name several times (e.g., "*Jane* walked along the street" when Jane was the participant in the self-reference condition) as a police

narrative normally does. This was to help activate the self of participants in the self-reference condition.

Memory Test. The memory test consisted of a 17-item recognition test followed by a source memory test after the misinformation phase. In the recognition test, participants answered questions about details of the crime in the slideshow. Each question (e.g., what was the name of the video store?) was provided with three alternatives: for misinformed questions, a correct answer (i.e., Video Americain), a misinformed answer (i.e., Video Internationale), and a filler (i.e., Video Starrz) were presented; for non-misinformed questions, a correct answer and two fillers were presented. Participants answered the memory questions via Qualtrics in the lab. Participants were specifically instructed to select the answer that they remembered seeing in the original slideshow. Six questions referred to the misinformed slides, while other questions measured non-misinformed true memory. After the recognition test, a source memory test asked participants from which presentation source they remembered their recognition answers (e.g., What is the name of the video store that Jane entered?): (1) saw in the picture only, (2) saw in the narrative only, (3) saw in both and they were the same, (4) saw in both and they conflicted, and (5) guessed (see Okado & Stark, 2005). There was one source memory question for every recognition test question.

Procedure

The experiment had two sessions. In session 1, participants provided demographic data and the experimenter took pictures of the participant in various poses with a white background so that their images could be photoshopped into the crime slideshow. Then participants were randomly assigned to the self-reference (n = 34) or other-reference (n = 34) condition, and pictures of those who were in the self-

reference condition would be photoshopped as the victim in the crime slideshow. Session 1 took around 15 minutes.

One week later, participants returned to the lab for session 2, which consisted of a study phase, a misinformation phase, and a memory test phase. The methodology basically followed the procedure in previous research (Patihis et al., 2013). In the study phase, all participants viewed the photoshopped slideshows of the crime. The key manipulation was that every two participants watched the same photoshopped slideshow individually, with one participant photoshopped in as the victim in the crime and the other participant saw the same slides where they were not the victim. Fifteen minutes of a filler task after the study phase, participants read the police narrative that contained certain misinformation. Finally, a memory test was administered 15 minutes after the misinformation phase. During the filler tasks, participants completed irrelevant questionnaires and played the game Bejeweled for 15 minutes. The second session took approximately 50 minutes.

Results and Discussion

Overall False Memory

During the memory test, participants were asked what they remembered seeing *in the original slideshow of photographs*. When participants chose the misinformation (e.g., “stealing the wallet with the right hand” while in fact it was the left hand) in the recognition test, this indicated that they had incorporated the piece of misinformation in their memory of the original crime slideshow and thus was classified as a false memory. An independent samples t-test was performed on the overall false memories in the self- and other-reference conditions. As Figure 2 shows, when participants viewed themselves as victims in the crime, they displayed a statistically higher number of overall false memories (M = 2.74, 95% CI [2.23, 3.24]) after receiving

misinformation than participants who viewed the crime as mock bystanders (*M* = 1.77, 95% CI [1.24, 2.29]), *t*(66) = 2.72, *p* = .008, $Mean_{difference}$ = 0.97, *d* = 0.66.

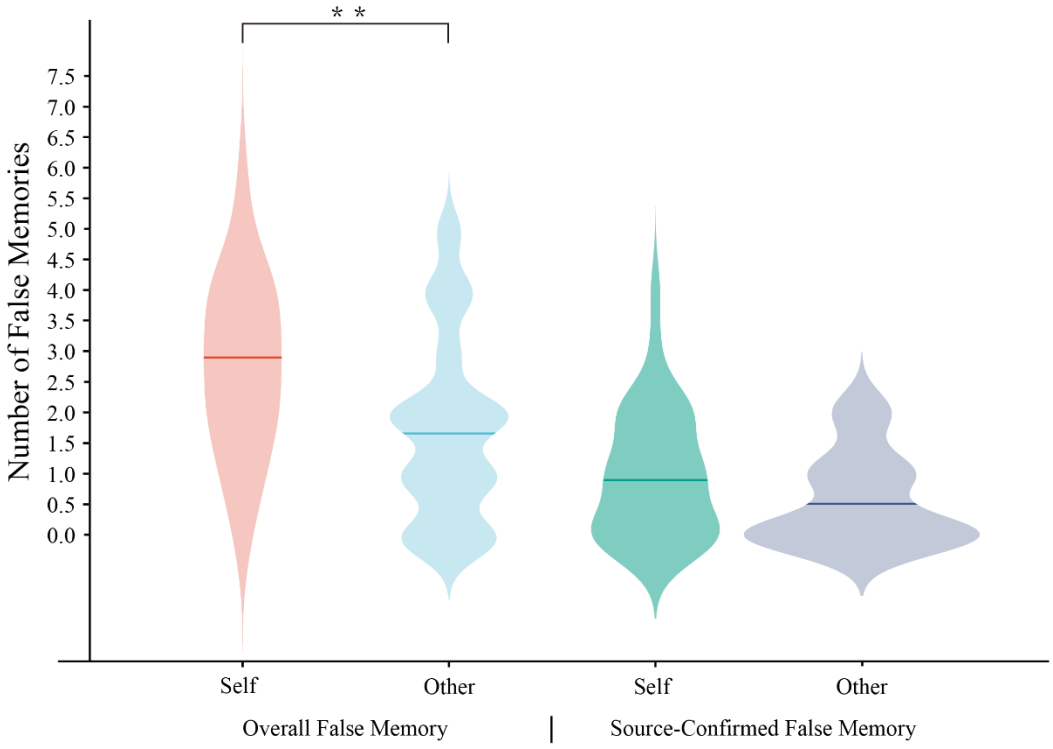

Figure 2. Violin plot demonstrating the distribution of number of overall false memories and source-confirmed false memories in the self- and other-reference conditions. The solid line within each distribution shape represents the mean.

Source-Confirmed False Memory

We further examined whether participants in the self-reference condition had more source-confirmed false memories than participants in the other-reference condition. A source-confirmed false memory is a false memory error at the memory test stage that is then followed up in the source test with either "I saw it in the picture only" or "I saw it both and they were the same" (see Patihis et al., 2013). Results showed that the Self-reference condition (*M* = 0.97, 95%CI[0.61, 1.33]) had more source-confirmed false memories than the other-reference condition (*M* = 0.56, 95%CI[0.30, 0.82]), *t*(66) = 1.89, *p* = .03 (one-tailed, based on directional hypothesis), *d* = 0.46.

Memory Accuracy on Non-Misinformation Items

For the items that did not involve misinformation at the narrative stage, we also compared participants' memory accuracy for non-misinformed details in the self- and other-reference conditions. There was no statistically significant difference in the number of correct memories between the self-reference condition (M = 5.59, 95% CI [4.99, 6.19]) and the other-reference condition (M = 5.79, 95% CI [5.32, 6.27]), $t(66) = 0.55$, $p = .59$, $d = 0.13$. Likewise, for source-confirmed true memories, there was no statistically significant difference between the self-reference condition (M = 3.06, 95% CI [2.40, 3.72]) and the other-reference condition (M = 3.06, 95% CI [2.46, 3.65]), $t(66) < 0.01$, $p > .99$, $d < 0.01$.

Exploratory Analysis: Central versus Peripheral Details

To explore potential mechanisms underlying the enhancing effect of self on suggestibility, we coded the misinformed details as central or peripheral and examined whether self-reference affected false memories of central and peripheral details differently. Central information was defined as any detail pertinent to central characters (i.e., the victim and the thief) in the plot (Christianson & Loftus, 1991), while other contextual details were coded as peripheral information. We asked a group of extra 30 participants (12 males and 18 females, M_{age} = 23.77, SD = 2.20) to rate the peripheral-central ratings on a 1 (very peripheral) to 6 (very central) scale (Luna, & Albuquerque, 2018). Items that scored the top 5% percentile were coded as central and items that scored the lower 5% percentile were coded as peripheral items. Of the six misinformed details, four were coded as central (i.e., *with which hand the man took the victim's wallet, where he hid the wallet,* and *where he hid, one of the items that fell out of the victim's bag*), and two were coded as peripheral (i.e., *the name of the shop that the victim entered*, and *the backpack color of a pedestrian*). As

Table 2 shows, we calculated the proportion of accepted misinformation (i.e., false memory) for central and peripheral details, respectively.

We conducted a 2×2 repeated measures ANOVA to test the effect of Self-reference (self vs. other) and Detail salience (central vs. peripheral) with Self-reference as a between-subjects variable on the proportion of accepted misinformation. The main effect of Self-reference was statistically significant, $F(1, 66) = 8.01$, $p = .006$, partial $\eta^2 = .11$, with participants in the self-reference condition accepting overall more misinformation than participants in the other-reference condition. The main effect of Detail salience, $F(1, 66) = 2.56$, $p = .11$, partial $\eta^2 = .04$, and the interaction between Self-reference and Detail salience, $F(1, 66) = 0.29$, $p = .60$, partial $\eta^2 = .004$, were statistically non-significant. These exploratory results imply that the self-enhancing false memory effect had similar impact on central and peripheral details.

Table 2. Proportion of false and true memories with 95% confidence intervals for central and peripheral details in the self-reference and other-reference conditions (Experiment 1).

	Self-reference	Other-reference
False Memory:		
Central details	0.43 [0.33, 0.52]	0.28 [0.18, 0.38]
Peripheral details	0.52 [0.41, 0.62]	0.32 [0.21, 0.44]
True Memory:		
Central details	0.56 [0.38, 0.73]	0.44 [0.27, 0.62]
Peripheral details	0.48 [0.42, 0.55]	0.58 [0.52, 0.65]

We also examined the effect of self-reference on true memories for central and peripheral details. Of the non-misinformed details, only one detail was rated as central by participants and 6 details were rated as peripheral. Self-reference condition had

higher descriptive true memories than the other-reference condition, but because there were too few items, we could not make any valid statistical comparisons. For peripheral true memories, participants in the self-reference condition remembered fewer peripheral details than those in the other-reference condition, $t(66) = 2.26$, $p = .03$, $d = 0.55$. Thus, it is possible that self-reference made participants focus more on central details and not the peripheral details.

As expected, we found a self-enhanced suggestibility effect in Experiment 1. Participants were more likely to report misinformation when they encoded a self-referential crime than when they encoded an other-referential crime. For the unstandardized effect size, we found that self-reference could increase accepted misinformation by almost one piece (out of six) relative to the other-reference condition which might be viewed as a practically relevant effect (Otgaar et al., 2022). This effect was also observed in our source memory data, although this effect was smaller in size compared to the overall false memory effect.

Although we found a significant effect of self-reference on overall false memory, the effect of self-reference on source-confirmed false memory was somewhat uncertain. Another study with more power to detect the effect of self-reference on source-confirmed false memory was needed. To replicate the self-enhanced suggestibility effect and further examine the generalizability of this effect, we conducted Experiment 2 in a different sample from a different country. One possible explanation for the self-enhanced suggestibility effect is that seeing one's own face might attract one's attention (Humphreys & Sui, 2016), making participants focusing on the central details instead of peripheral details. Participants' weaker true memory for peripheral details seems to support this mechanism. However, we did not observe different misinformation effects on central versus peripheral details in the

self-reference condition, suggesting that both types of details were susceptible to misinformation. Because results on central versus peripheral details in Experiment 1 were exploratory but not confirmatory, another aim of Experiment 2 was to confirm whether the self-enhanced suggestibility effect was similar for central and peripheral details. Furthermore, during the experiment, participants in the self and other reference conditions might experience different intensity of emotions. We measured participants' emotions after they watched the crime in Experiment 2 to control participants' level of emotions.

Experiment 2

Experiment 2 followed the same design and procedure as in Experiment 1 with the following exceptions. First, we measured participants' emotions immediately after they watched the crime slideshow. Second, with a confirmatory purpose, we categorized the misinformed details as central or peripheral to investigate whether detail saliency similarly affected acceptance of misinformation in the self relative to the other reference condition. Finally, we increased the number of slide images of the crime event to make the event more coherent.

Method

Participants

An a priori power analysis with a power of .95 (α= .05; two tailed) and an effect size of d = 0.66 (based on the effect of self-reference on overall false memory in Experiment 1) showed that one hundred and twenty-two participants were needed. Participants (N = 122; 49 males, 73 females) were 22.5 years old on average (SD = 3.54; range 18-26 years). There were 61 participants (24 males) in the self-reference condition and 61 participants (25 males) in the other-reference condition. Participants were recruited from Fudan University, Shanghai, China, and received ¥50 for their

participation in the experiment. The experiment was approved by the Institutional Review Board at Fudan University.

Materials, Design and Procedure

The same crime vignette from Experiment 1 was used in Experiment 2. However, because participants were Chinese, photographs of the crime slideshow were re-taken on a street in Shanghai and the perpetrator, the victim, and bystanders were all Chinese. Hence, the crime event was the same as in Experiment 1 except that the image context and the people in the images were changed. Also, to make the crime event more coherent, we selected and re-made 42 images from the original slideshow (Okado & Stark, 2005) rather than 32. Accordingly, we also added one more piece of misinformation to make the overall misinformation rate comparable in the two experiments, leading to a total of seven pieces of misinformation. All verbal materials (e.g., instructions, the police narrative, questions in the memory test) were translated into Chinese. The design and procedure were exactly the same as in Experiment 1 with the exception that we measured participants' emotions after the crime slideshow using the Positive Affect and Negative Affect Scale Chinese Version (PANAS, Lin, Zheng, & Wang, 2008; Watson, Clark, & Tellegen, 1988). The PANAS contains nine items (e.g., Happy, Cheerful) measuring positive emotion and nine items (e.g., Ashamed, Upset) measuring negative emotion on a 1 to 5 Likert scale (1 = *Not at all*, 5 = *Extremely*).

Results and Discussion

Overall and Source-confirmed False Memory

We again found that participants in the self-reference condition (M = 4.10, 95% CI [3.66, 4.54]) had statistically more false memories than participants in the other-reference condition (M = 3.36, 95% CI [2.93, 3.79]), $t(120) = 2.38$, $p = .019$,

$Mean_{difference}$ = 0.74, d = 0.43. There was no statistically significant difference on the number of source-confirmed false memories between the self-reference (M = 1.56, 95% CI [1.28, 1.84]) and the other-reference conditions (M = 1.56, 95% CI [1.24, 1.88]), $t(120) < 0.01$, $p > .99$, $d < 0.01$.

Memory Accuracy on Non-Misinformation Items

For overall true memory, participants in the self-reference condition (M = 7.23, 95% CI [6.79, 7.67]) had similar number of correct memories as those in the other-reference condition (M = 7.72, 95% CI [7.31, 8.13]), $t(120) = 1.64$, $p = .11$, $Mean_{difference}$ = 0.49, d = 0.29. Meanwhile, there was a statistical difference for the number of source-confirmed true memories with the self-reference condition (M = 3.89, 95% CI [3.47, 4.30]) scoring lower than the other-reference condition (M = 4.97, 95% CI [4.47, 5.47]), $t(120) = 3.35$, $p = .001$, $Mean_{difference}$ = 1.08, d = 0.61. This may due to the fact that most non-misinformed items were peripheral details.

Central versus Peripheral Details

Of the seven misinformed details, four were rated as central and two were rated as peripheral. Table 3 shows the proportion of accepted misinformation (i.e., false memory) for central and peripheral details. A 2 (Self-reference: Self vs. Other) ×2 (Detail salience: Central vs. Peripheral) repeated measures ANOVA on the proportion of accepted misinformation revealed a significant main effect of Self-reference, $F(1, 120) = 4.18$, $p = .043$, partial $\eta^2 = .03$, confirming that the self-enhancing effect had similar impact on central and peripheral details. There was also a significant main effect of Detail salience, $F(1, 120) = 4.10$, $p = .045$, partial $\eta^2 = .03$, which suggests that peripheral details were more easily to be misled and accepted as false memories than central details. No significant interaction between Reference and Details was found, $F(1, 120) = 0.35$, $p = .55$, partial $\eta^2 = .003$.

Table 3. Proportion of false and true memories with 95% confidence intervals for central and peripheral details in the self-reference and other-reference conditions (Experiment 2).

	Self-reference	Other-reference
False Memory:		
Central details	0.54 [0.46, 0.63]	0.42 [0.34, 0.50]
Peripheral details	0.60 [0.50, 0.68]	0.51 [0.42, 0.60]
True Memory:		
Central details	0.70 [0.59, 0.82]	0.74 [0.62, 0.85]
Peripheral details	0.62 [0.57, 0.68]	0.69 [0.64, 0.73]

Similar to Experiment 1, for non-misinformed details, as there was only one detail coded as central, we only conducted an independent samples t-test for peripheral details. Consistent with results in Experiment 1, participants in the self-reference condition had slightly lower true memories for peripheral details than participants in the other-reference condition, but the difference was not statistically significant, $t(120) = 1.85$, $p = .067$, $d = 0.34$.

Emotion Scores

We measured participants' positive and negative emotions immediately after they watched the crime slideshow using the PANAS. We compared the positive and negative emotions evoked by the crime slideshow in the self-reference and other-reference conditions. Participants in the self-reference condition had comparable positive emotions ($M = 1.96$, 95% CI [1.79, 2.12]) as participants in the other-reference condition ($M = 1.73$, 95% CI [1.57, 1.89]), $t(120) = 1.94$, $p = .06$, $d = 0.35$. However, participants in the self-reference condition ($M = 2.25$, 95% CI [2.05, 2.45]) had significantly higher levels of negative emotions than participants in the other-reference condition ($M = 1.94$, 95% CI [1.78, 2.09]), $t(120) = 2.46$, $p = .015$, $d = 0.46$.

Table 4 presents descriptive data on each dimension of positive and negative emotions.

Table 4. Mean PANAS scores with 95% confidence intervals (in brackets) of negative and positive emotions (1-5 Likert scale) in the self-reference and other-reference conditions.

PANAS	Self-reference	Other-reference
Negative Emotion*:	**2.25 [2.05, 2.45]**	**1.94 [1.78, 2.09]**
Ashamed*	1.89 [1.60, 2.17]	1.36 [1.21, 1.51]
Upset	2.16 [1.84, 2.49]	1.92 [1.65, 2.18]
Afraid	2.23 [1.96, 2.50]	1.97 [1.72, 2.21]
Nervous	3.21 [2.93, 3.50]	2.92 [2.61, 3.23]
Scared	2.02 [1.73, 2.31]	1.89 [1.66, 2.11]
Guilty*	1.74 [1.43, 1.97]	1.36 [1.18, 1.54]
Irritable	2.15 [1.86, 2.43]	1.84 [1.65, 2.02]
Jittery	2.39 [2.11, 2.68]	2.15 [1.86, 2.44]
Peeved*	2.51 [2.22, 2.80]	2.03 [1.76, 2.30]
Positive Emotion:	**1.96 [1.79, 2.12]**	**1.73 [1.57, 1.89]**
Active	2.18 [1.90, 2.46]	2.15 [1.86, 2.44]
Enthusiastic	2.03 [1.78, 2.28]	1.87 [1.66, 2.08]
Happy	1.85 [1.59, 2.12]	1.56 [1.32, 1.80]
Cheerful	1.72 [1.50, 1.94]	1.49 [1.26, 1.72]
Excited	2.36 [2.10, 2.63]	2.08 [1.81, 2.36]
Proud	1.36 [1.21, 1.51]	1.20 [1.07, 1.33]
Delighted	1.69 [1.48, 1.90]	1.52 [1.32, 1.73]
Energetic	2.46 [2.16, 2.76]	2.38 [2.08, 2.67]
Grateful*	1.95 [1.63, 2.28]	1.33 [1.15, 1.50]

Note: Emotions marked with * showed statistical differences between the self and other reference conditions (ps < .05).

We also examined whether positive or negative emotion predicted the number of false memories. Correlational analyses showed that, in the self-reference group, the average negative emotion score significantly correlated with the number of overall false memories, $r(59)= 0.28$, $p = .027$, suggesting that the more negative they felt, the easier they accepted suggestive information, while positive emotion score did not correlate with the number overall false memories, $r(59) = -0.06$, $p = .65$. However, in

the other-reference condition, no statistically significant correlations emerged between positive or negative emotions and number of overall false memories, all *p*s > .05. Because self-reference had a significant impact on Ashamed, Guilty and Peeved in the PANAS (see Table 4), we averaged these three negative emotions and made it a new "Negative Emotion" variable. We conducted an ANCOVA analysis on the effect of self-reference on overall false memory while controlling for Negative Emotion, in order to examine whether the effect of self-reference on false memory was driven by negative emotion. Results showed that self-reference still exhibited a significant impact on overall false memory when controlling for negative emotion, $F(1, 119) = 9.35$, $p = .003$, partial $\eta^2 = .07$, suggesting that self-reference impacted false memory independently.

General Discussion

In two experiments, we found a self-enhanced suggestibility effect. That is, when participants encoded (and thus retrieved) a highly self-referential crime event with themselves being the victim, they were more likely to accept misinformation than when participants encoded the crime from a bystander witness's perspective. The effect emerged in two experiments with samples from different countries. In general, self-reference led to an increase of 0.74 ~ 1 piece of accepted misinformation relative to other-reference. Moreover, in two Experiments, self- reference increased false memories for both central and peripheral details. These results suggest that self-reference can enhance one's susceptibility to misleading information, leading to more misinformed false memories.

There are several potential mechanisms underlying the self-enhanced suggestibility effect that may work at different memory stages. One possible mechanism lies at the encoding phase. That is, participants' attention may be drawn to

their own face during encoding, which might make their overall peripheral memory of the crime weaker and thus increase their susceptibility to misinformation. Indeed, self-related stimuli including one's own face can easily capture one's attention (Humphreys & Sui, 2016). In Experiment 1, we found that participants in the self-reference condition had lower true memories for non-misled peripheral details. This suggests that participants might focus more on peripheral details in the other-reference than in the self-reference condition. The question is whether such attentional bias can affect participants' suggestibility to misinformation related to the crime event. In Experiment 2, we found that peripheral details were more easily to be misled and accepted as false memories than central details, but this effect did not interact with the self-reference effect on false memory. That is, in both experiments, we found a similar impact of self-reference on false memory for central and peripheral details. Further research is needed to examine the relationship between self and memory for central/peripheral information.

Another possible mechanism underlying the self-enhanced suggestibility lies in the memory retrieval process. Mechanisms underlying the misinformation effect suggest that, when memory is reactivated during the misinformation phase, memory can be reconsolidated and vulnerable to changes including errors (Chan & LaPaglia, 2013; Rindal et al., 2016). During the misinformation phase in our study (i.e., when participants read the narratives containing misinformation), the narratives reactivated participants' memories of the crime and the misinformation imbedded in the narratives might have been incorporated in their original memory. Critically, for participants in the self-reference condition, because they were pictured as the victims in the crime, reactivating their crime memory might also have activated a sense of the self. According to mechanisms underlying the self-construct, activating the self could

facilitate (false) binding of non-experienced stimuli into the memory network (Sui & Humphreys, 2015; Wang et al., 2019, 2021a). Hence, participants in the self-reference condition were more likely to incorporate misinformation into their memory and thus formed more false memories.

A third mechanism for self-enhanced suggestibility might be an effect of emotion evoked by the self-referential crime. Indeed, victims in real crimes usually suffer from extremely negative emotions, and negative emotion can lead to greater susceptibility to misinformation than positive emotion (Porter et al., 2010; Van Damme & Smets, 2014). For example, Porter and colleagues (2010) presented participants with negative or positive images and later exposed them with misinformation concerning the images. They found that negative images induced more false memories for major misleading information than positive images. In our Experiment 2, participants in the self-reference condition experienced significantly higher levels of negative emotion that those in the other-reference condition. We also found that the stronger negative emotion participants felt, the more false memories they formed in the victim condition. Interestingly, after controlling for negative emotion, we still found that self-reference had a significant impact on overall false memory. These results suggest that, besides negative emotions, self-reference might exhibit a unique impact participants' susceptibility to false memory. However, the current study did not manipulate participants' emotion directly and the emotions evoked here were with relatively mild (e.g., a mean rating of 2.25 on a 1-5 scale). Future research is needed to examine the role of emotion in victim and bystander witnesses' memories.

When taking in account source monitoring information, the impact of self-reference on false memory formation was weakened or diminished. In the European

sample of Experiment 1, we observed slightly more source-confirmed false memories in the self-reference condition than in the other-reference condition. However, this effect did not replicate with a Chinese sample in Experiment 2. There are two possible explanations. One possibility is that results on source-confirmed false memory in Experiment 1 might be a false positive, suggesting that a source memory test could attenuate the enhanced suggestibility of the self. Another possibility is that there might be cultural differences concerning the effect of self-reference on source-confirmed false memory. It is well established that there are cultural differences on the self-construct (Markus & Katayama, 1991). European participants have shown to form more self-related false memories of item-context bindings (i.e., source memory) than Chinese participants (Wang et al., 2021b). Hence, the impact of the self on source-confirmed false memory might be salient in Europeans but absent in Chinese. Nevertheless, our results imply that source monitoring might be beneficial in reducing self-enhanced suggestibility.

As for overall true memory, self-reference did not affect participants' memory accuracy for non-misinformed details in Experiments 1 and 2, whereas there were fewer source-confirmed correct memories in the self-reference than the other-reference condition in Experiment 2. When we categorized event details as central or peripheral, we even found that other-reference had an advantage on correct memory for peripheral details than self-reference. Such results seem to be inconsistent with the superior memory effect of self-reference (e.g., Klein, 2012). There are two possible reasons. First, most of our non-misinformed items were peripheral details, and it is possible that self-reference draws participants' attention to central details. This may lead to worse memories for peripheral details and cancel out the superior memory effect of self-reference. Another possible reason is that our manipulation of self

versus other differed substantially from those in previous research. In classical self-reference studies, participants either judged whether some words could describe oneself relative to others (Kuiper & Rogers, 1979) or to pair stimuli with oneself versus others (Leshikar, Dulas, & Duarte, 2015), which aimed to direct participants' attention to the relationship between the stimuli and themselves. However, here we used a between-subjects design (e.g., Conway & Dewhurst, 1995) and manipulated the self-reference of a crime event by embedding one's image in a rich event, which did not even require participants to notice a self versus other difference while encoding the information.

One limitation of the current study is that we constructed locally relevant photo stimuli to reduce any culture-related bias, which may introduce potential confounds in our research design. Another limitation may be a lack of ecological validity of applying the current results in legal contexts. We were primarily interested in whether self-reference impacted suggestive false memory by comparing encoding a crime related to oneself relative to encoding a crime related to others, but we did not compare false memories of victims and bystanders of the same crime directly. That is, we photoshopped participants' images in a crime slideshow instead of making the participants real victims. This might limit how the current results can be transferred to real cases. However, the current study has raised interesting questions related to victim and eyewitness memory in real settings. Around one third to half of people in real life can spontaneously retrieve their autobiographical memories from an observer's perspective via seeing themselves in their memories, providing evidence for the reconstructive nature of episodic memory because they cannot "see" themselves (Kenny & Bryant, 2006; Robinson & Swanson, 1993; St. Jacques, 2019). By photoshopping participants' own images in an event, our experimental

manipulation can potentially simulate memories of those who retrieved autobiographical memories from an observer's perspective. Research showed that people who have experienced traumatic events (e.g., being a victim of a severe crime) are more likely to recall their trauma from an observer's perspective (McIsaac & Eich, 2004; Kenny & Bryant, 2007). When victims of real crimes reconstruct their autobiographical memories from an observer's perspective, would their memories be more susceptible to false memory formation? Future research can investigate false memory susceptibility of real victims and bystanders.

In conclusion, a self-enhanced suggestibility effect emerged in two experiments. Participants who viewed themselves as victims in a crime slideshow were more susceptible to form false memories than those who witnessed the crime as a bystander. Furthermore, source monitoring might weaken this effect of the self on false memory formation. This work raises the question of whether self-reference could constitute a new risk factor to be considered when evaluating victim/eyewitness' memory reports, especially when they retrieve autobiographical memories from an observer's perspective. Even before these questions are fully tested in real world settings, the precautionary principle would advise legal practitioners to protect victim's memories from the influence of misinformation.

Open access

All data can be accessed at https://osf.io/dhr7w/

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