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The effects of varying negativity and presentation duration of images on formation of false memories

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Abstract:

Studies about“False memory” are developing in the field of cognitive psychology. This study aims to investigate the interplay between presentation duration, negativity, and the presence of misinformation in the formation of false memories. Participants were exposed to slides of varying emotional valences (negative and neutral) and presentation durations (long and short), followed by questions containing either target or false options (either “critical lures” or “foil”. Confidence levels for each response were also recorded. The study found that subjects were more prone to false memories when presented with misinformation in the form of critical questions, especially when the slides were negatively valenced. Furthermore, confidence levels for artificially generated false memories were significantly higher in the long-duration group but lower in the short-duration group. These findings suggest that the presence of misinformation and the emotional valence of the stimuli significantly influence the formation of false memories.

Keywords: Misinformation, false memory, emotional intensity, duration

1. Introduction

People experience various events every day, and these past experiences are often stored in our brains as memories. However, memories are not always accurate; instead, they can be partially distorted or even entirely altered, leading to the formation of “false memory”(Loftus & Palmer, 1974). This concept may be the one that people must focus on when it comes to “trauma”, e.g. verbal and physical violence, sexual abuse, or being a survivor after a pandemic. Specifically, according to the National Council for Mental Wellbeing, at least once in their lives, 70% of U.S. adults have experienced a traumatic event—following the experience of an overwhelming event, the memory of individuals can sometimes be shaped (Loftus, 1978), which may make the situation worse because it is likely to hinder various events that are probably important to these survivors of traumatic experiences from going smoothly. For example, due to memory distortion, extra time may be spent on identifying the reliability of eyewitness testimony in court (Loftus, 1980).

The misinformation effect, first mentioned by Elizabeth. F. Loftus in 1970s (e.g. Loftus, 1975), is a phenomenon of memory impairment after exposure to misleading post-event information, which provides a solid basis for the next 40 years of research and may explain why survivors sometimes give wrong identification or description about their traumatic experiences. However, when we go back to the point where trauma occurs, it can be seen that people are often placed in a scenario where they passively witness and sense different levels of emotional intensity with different lengths of duration—the variables that may still need to be investigated since, even though there are already a number of relevant studies based on the former either in the field of false memory or memory only (see Literature review for details), it still remains uncertain whether people’s false memory formation is different when the 2 work interconnectedly, and duration is indeed an unavoidable factor that worths consideration, not to mention that the interpretation derived may someday help to build a more comprehensive understanding in the area of mental health, hopefully, PTSD (Posttraumatic Stress Disorder) treatment, and legal applications.

Based on a motivation to study the misinformation effect, the aim of the study is to, by integrating text and visual information, investigate the influence of negativity and presenting duration of visual stimuli on the formation of false memory following the typical 3-stage procedure of “Misinformation Paradigm”, and the correlaton between different types of false memory and confidence level.

2. Literature Review

2.1 Commonly used methods to trigger false memory

Research into memory has gained pace in recent decades, which has expanded more and more well-developed branches: false memory, a phenomenon in which individ-

uals generate distorted or even completely nonexistent memory after certain stimuli (e.g., Loftus, 1997; 2004), is one of them. Several methods have been commonly used in experiments to generate false memory (Otgaar, Houben, & Howe, 2018) , e.g. implantation, DRM word lists, and misinformation, while some studies have already narrowed the focus to the effects of emotion since the emotional intensity of the stimuli is widely considered a factor that plays a vital role in influencing the memorizing ability: the nature of the emotional content of an event can be interpreted by 2 dimensions, namely valence, and arousal. Valence shows a continuous nature that delineates the degree of positivity or negativity, while arousal refers to the level of activation evoked by a certain stimulus, ranging from relaxing to exciting (Van Damme, & Smets, 2014). The following chapters review the aforementioned 3 methods from the perspectives of mechanisms and emotions.

2.1.1 Implantation

The implantation approach, i.e. embedding entirely fabricated experiences into one's memory (Otgaar & Candel, 2011), may be one of the methods that hold significant practical quality to everyday life since in a large number of studies, it was used to investigate problems about childhood. One of the earliest studies investigating the effects of tailored suggestions was conducted by Loftus and Pickrell in 1995, in which subjects were given 4 short customized stories related to their childhood, in which the false events were always embedded in the 3rd position. Later, subjects were interviewed to recall each of the 4 events. Finally, 29% of subjects were found to internalize the entirely false event.

Although studies related to valence or arousal are rarely seen in this field, researchers have done several implantation experiments related to emotional childhood experiences. For example, Bernstein et al. (2005) investigated whether individuals would be led to falsely believe a childhood experience of sickness after eating either hard-boiled eggs or dill pickles did occur after suggestions. In the end, the results of the "Memory or Belief?" questionnaire indicated that people were likely to have either belief or memory about a nonexistent or at least an unremembered negative experience. On the contrary, for a following study aiming to understand if implantation would still succeed in terms of positive food memory by embedding the false suggestion "loved asparagus the first time you tried it" in the 16th position of a questionnaire, the results also demonstrate that adults can have the same response even if the experience is positive, even alter their attitude toward the food into positive (Laney et al., 2008).

2.1.2 DRM illusion

Deese/Roediger-McDermott (DRM) paradigm, first built by Deese in 1959, replicated and adapted by Roediger and McDermott in 1995, is thought to be a robust way to induce false recall (e.g. Huff, Bodner, & Gretz, 2020; Otgaar, & Howe, 2018). Within the DRM paradigm, individuals are shown lists of associates (e.g. table, sit, legs, seat, soft, desk, arm) that eventually lead to recall of non-studied items (e.g. chair). In Experiment 2, a false recall rate was found to be 55%, and the false alarms rate was almost equal to the hit rate in the recognition test (Roediger, & McDermott, 1995).

Emotions also have an impact on the recall of word lists, as subjects who received a negative mood and then participated in a false-memory task to study neutral items showed increased false memories (Roediger et al., 2001). Budson et al. (2006) developed lists of targets (e.g. sex, man) to connect with associates that had negative valences (e.g. rape)—in the end, a significant false alarms rate was reported for those negatively valenced words, however, this rate was equivalent to neutral-word rate. One possible explanation could be the use of variables: arousal and valence are 2 different things because their effects vary on memory (Kensinger, 2004), for example, in the Cornell/ Cortland Emotion Lists (CEL) developed by Brainerd et al. (2008), valence and arousal levels vary; in the study of Brainerd et al. (2008), they controlled arousal to test different valenced materials. This time, false memory was highest for negative materials.

2.1.3 Misinformation

The misinformation paradigm may be the most well-developed method (e.g. Geiselman & Padilla,1988; Kohnken & Brockmann, 1987; Sheehan & Tilden, 1986; Smith & Ellsworth, 1987): experiments typically followed the simple 3-step procedure (Loftus, 2005). First, materials, e.g. slides, are shown to the subjects; next, subjects receive misleading information; finally, they are tested on their memory. For example, in a famous experiment conducted by Loftus, Miller, & Burns in 1978, subjects saw a series of 30 slides, but half saw a red Datsun stopped at a yield sign while the other half saw the stop sign; subsequently, they filled out a questionnaire that had misinformation in the questions; finally, a forced-choice recognition test was carried out. Based on this paradigm, the "misinformation effect" was found suggesting that people who have been exposed to misleading post-event information incorporate this information into their original memory (Frenda, Nichols, & Loftus, 2011).

Porter, Spencer, and Birt (2003) are considered the first groups of researchers to examine the impact of the valence of a scene on false memories within the misinformation paradigm (Van Damme, & Smets, 2014). Subjects viewed

either a highly positive, neutral, or negative emotional event as the first step. As a result, individuals were more likely to recollect misleading details for the negatively valenced images, especially for peripheral details (see the chapter below for further explanation) than positive or neutral did. The results are further supported by the following experiment (Porter et al. 2010).In the study of Van Damme and Smets in 2014, they also followed the misinformation paradigm, but the main difference is that arousal level was another independent variable. Subjects were shown six types of photographs with different combinations of levels of valence and arousal and were tested on their false memory for central and peripheral details in the final recognition test. Results show that control participants' ability to choose false central information was hindered by negative valence and arousal.

2.2 Emotional content of memory: possible explanations

It is widely thought that emotional information enhances recall (Christianson, 1992) like common sense. One example is the brain imaging study conducted by Canli et al., in which subjects were required to indicate their subjective received emotional intensity by pressing one button when viewing neutral or negative slides: results show that the amygdala responded most strongly to emotionally arousing scenes and which facilitated memory (see Canli et al. 2000); in a lot more real-life field, trauma, there is a scientific consensus supporting that it improves memory. For instance, sexual trauma memories were associated with a high level of vividness, detail, and sensory components, rather than fragments (Peace, Porter, & Brinkle, 2008).

However, the oppositive view suggests that traumatic experiences are more likely to impair memory. Specifically, the view is narrowed to the perspective of false memory: memory is subject to alteration and susceptible to distortion (Strange & Talarangi, 2015); according to Otgaar et al. (2017), the introduction of emotional information to participants with PTSD resulted in an increase in the level of vulnerability to false memory. Although it may be counterintuitive to realize that individuals who experience emotional experiences are prone to generate inaccurate memories, more studies focusing on this field have reported a more in-depth finding that could justify both sides: people exhibit differential recall of details and body information from emotional situations compared to those from neutral situations (Burke et al., 1992; Christianson & Loftus, 1991), which may be explained by "attention narrowing"—a narrowing of the spectrum of stimuli to which an individual is sensitive, which is led by physiological arousal or emotion (Bruner, Matter, & Papanek, 1955; Easterbrook, 1959). In the study conducted by Christianson and Loftus in 1987, subjects who had seen emotional stimuli showed an improved ability to memorize, for example, they could recall the key points of a film or the central details of emotional slides better while being more likely to fail to identify which specific slides they saw, which indicates that in the case of emotional events, while the core information may be kept well in mind, peripheral information is likely to be lost. Moreover, in another experiment conducted by the two researchers later, they incidentally tested this phenomenon again: subjects saw either a neutral, unusual, or emotional version of a critical slide among a thematic series of 15 slides. Results show that when the critical slide was emotional (a woman injured near a bicycle), subjects had a superior recall of central information but a weaker recall of peripheral information, in contrast to subjects who viewed the neutral critical slide (a woman riding a bicycle) (Christianson & Loftus, 1991). Later, researchers named this phenomenon of enhancement in recall of emotional central details with an impairment in recall of peripheral details "emotion-induced memory trade-off" (Waring, & Kensinger, 2009) or "weapon focus" (Kaplan et al. 2016). In terms of false memory, as mentioned in the misinformation method, there are already experiments implementing this theory into practice. Therefore, an adapted explanation developed from these previous studies for the conflicts and the results of its aformentioned own studymay be a theory suggested by Porter, Taylor, & Ten Brinke in 2008, called the Paradoxical Negative Emotion (PNE) hypothesis. It is anticipated that negative emotions often enhance retention, while simultaneously increasing the susceptibility to false memories. Experimentally, it was found that subjects had a higher ability to recall a greater number of true negative events compared to real positive ones, and the vast majority of them were able to recall at least one fake event. In conclusion, while people tend to recall true negative memories more often than positive events, false negative memories are generally recalled with more details than false positive ones.

2.3 Presentation duration and research gap

With regards to the presentation duration, there are some researches giving contradicting results. Several of them have demonstrated that there is a positive correlation between presentation duration (e.g. Roediger, & McDermott, 1995; Seamon, Luo, & Gallo, 1998) and false memory, while others hold contrasting findings suggesting a negative correlation between these variables (e.g. Toglia, Neuschatz, & Goodwin, 1999; Neuschatz et al., 2001; Gallo et al., 2001). Therefore, to test the hypothesis that false recall levels may vary instead of increase or decrease in a linear way across different durations, McDermott

and Watson carried out a study using the DRM paradigm in 2001. When semantically connected word lists were presented for a shorter duration, false recall increased with increasing time; when the duration got longer after a peak time, false recall declined. In general, a U-shape curve was deduced to explain the previous conflicted findings. However, this explanation may not be applied to other methods to study false memory: for example, the misinformation paradigm, probably because of differences including the modality of stimuli (words or images)—inspired by which, this study pays attention to presentation duration of visual stimuli as one variable. Additionally, this study looks for the interconnected effects of emotion, duration, and presence of misinformation given that the previous studies might only have manipulated 1 or 2 of them.

3. Methodology

3.1 Materials

3.1.1 Stimuli: slides

There was a series of 16 slides selected from Open Affective Standardized Image Set (OASIS) (Kurdi, Lozano, & Banaji, 2017), including 4 categories: scene, object, person, and animal, with equal numbers in each (i.e. 2 neutral and 2 negative slides in each category). To define and select appropriate neutral and negative slides, each slide must address 2 conditions: it was either within the range of the first 1 over 3 (negative) or close to the midpoint (neutral) of all valences among the whole image set; it had sufficient visual information. By calculation, 8 slides with ratings of valence ranging from 1.99 to 1.39 were categorized as negative, 8 slides with ratings of valence ranging from 3.75 to 3.52 were neutral. The slides were presented, in a randomized order arranged by Notion AI, in the software Keynote on a 14-inch screen (MacBook Pro, 2021).

3.1.2 Misinformation questionnaire

There was a 16-question online fill-in-the-blank questionnaire every 16 questions in the questionnaire corresponded to one slide viewed and had 2 components: a stem that described the scene of a single slide and a question itself that asked one totally irrelevant detail in the slide serving as a distractor. On the top of the questionnaire page, there was an introduction that was deliberately designed to be casual and said that the aim of it was to test their memory and these overly-specific stems below were only for subjects to recall which slide the question was referring to. Nevertheless, it also had an unspoken function, i.e. to interject any misleading information to the stems smoothly.
Of all 16 questions, there were 6 critical questions in which stems were embedded with misinformation, i.e. a piece of false information altered from one peripheral detail (Christianson & Loftus, 1991) in the slides. Additionally, the 6 critical slides being altered with semantic misinformation were 4 negative and 2 neutral. Specifically, an online questionnaire asking which was the central and the peripheral detail respectively in every slide was given to a group of 20 subjects who were not involved in any task later. Consequently, the final misleading post-event information hidden in the 6 stems was chosen by addressing 2 conditions: the original detail should win the highest number of votes to choose the most peripheral one in each slide on the ballot; replacing it with misinformation should be practical (for example, in a slide depicting a car accident, it is difficult to replace "background" with another word since the word is too blurry even though 8 subjects picked it as the most peripheral detail). If the second requirement could not be met, choosing the detail that won the second-highest number of votes received in the rank was necessary. The order of questions was randomized.

3.1.3 Recognition test

There was a 16-question multiple-choice questionnaire to truly test whether they still kept their correct memory about the slides or they had false memory either naturally occurring or artificially occurring. In this questionnaire, the stems were much briefer than those in the questionnaire that contained misinformation since its function was only to enable subjects to recall which slides the question referred to. On the top of the questionnaire page, subjects were informed that this was a revised, clearer, and shorter version of the previous "memory test" and the aim of doing so was to compare the distinctions between the 2 types of questionnaire designs.
All 16 questions asked the information directly from the detailed stems of the previous questionnaire. Each question that corresponded to the critical slide, i.e. the critical stem had 3 responses to pick, which was similar to the one in the study conducted by Putnam, Sungkhasettee, and Roediger(2017): one accurate answer that was constant with the detail in the original slide shown (target); one that was precisely the same as the misinformation (critical lure); one that was irrelevant to neither the original scene nor the misinformation (foil). For the rest 10 questions that matched non-critical slides, the critical lures did not exist, so this type of response was substituted with a new foil. The order of questions was randomized.

3.1.3 Confidence test

Apart from answering the recognition test, subjects were asked to complete a confidence rating, which was inspired

by confidence measures used in previous research (e.g. Intraub & Hoffman, 1992; Koriat, Lichtenstein, & Fischhoff, 1980; Loftus, Miller & Burns, 1978; Loftus & Pickrell, 1995; Laney et al., 2008; Roediger & McDermott, 1995), for each answer they chose in the recognition test. On a scale of 1-3 in which 3 referred to 100% sure and 1 referred to guess, subjects were asked to rate to what extent they were sure about their answers.

3.2 Method

3.2.1 Method

There were 17 female subjects in total, mainly aged 17-18, except one aged 26 and 4 aged 18-25. Only females were chosen because they are thought to be more willing to engage in boring tasks (Eagly & Crowley, 1986), i.e. "repetitive reading tasks" in this study. All of them were obtained due to their availability of contacts online.

3.2.2 Design

The experiment was a 2 (presence of misinformation in the questionnaire: critical or non-critical) x 2 (negativity of photograph represented by valence: negative, neutral) x 2 (presentation duration: short, long) mixed-model design. The negativity of slides and the presence of misinformation was manipulated within subjects, whereas the presentation duration was manipulated between subjects.

3.2.3 Procedure

2 online meetings were organized for 2 groups of different durations. To disguise the true aim of the study, a brief but vague cover story was designed prior to the implementation of the whole experiment:

"I aim to study the relationship between visual stimulation and memory. This is a pilot study, thus it would be normal if you experience anything strange. "

Before showing subjects the slides, they were informed that they should try their best to memorize details in every slide as many as possible for the upcoming "memory test". With 1 s of an interstimulus interval presenting a fixation cross in the center of the screen (identical to the one used by Canli et al. in 2000) between each slide presented for either 1.25 s in the short-duration group or 6 s in the long-duration group, subjects viewed all 16 slides. Then they joined a filler activity: a 10-minute drawing task for avoiding monotony in the case of subjects being placed in a high load of reading.

Subjects were subsequently given the questionnaire containing misinformation that they believed to be the true memory test. They were told,

"Although there was no time limit for completing it, you will finish this faster than you did in the last task. If you can't recall the answer, please guess."

As soon as all questionnaires were collected, the researcher spoke up in a casual tone, pretending that she forgot there was another questionnaire yet to be completed, i.e. the true recognition test,

"When you were all doing the questionnaire, I suddenly realized I had another one for you to complete but forgot to tell you in advance! This questionnaire was designed to compare the effects of different types of question designs and to see which one is better. Now I'm gonna send you the QR code for that, please scan it…"

In order to alleviate any potential irritation caused by this unexpected task, she also added,

"This questionnaire can be completed much faster because it's MCQs only."

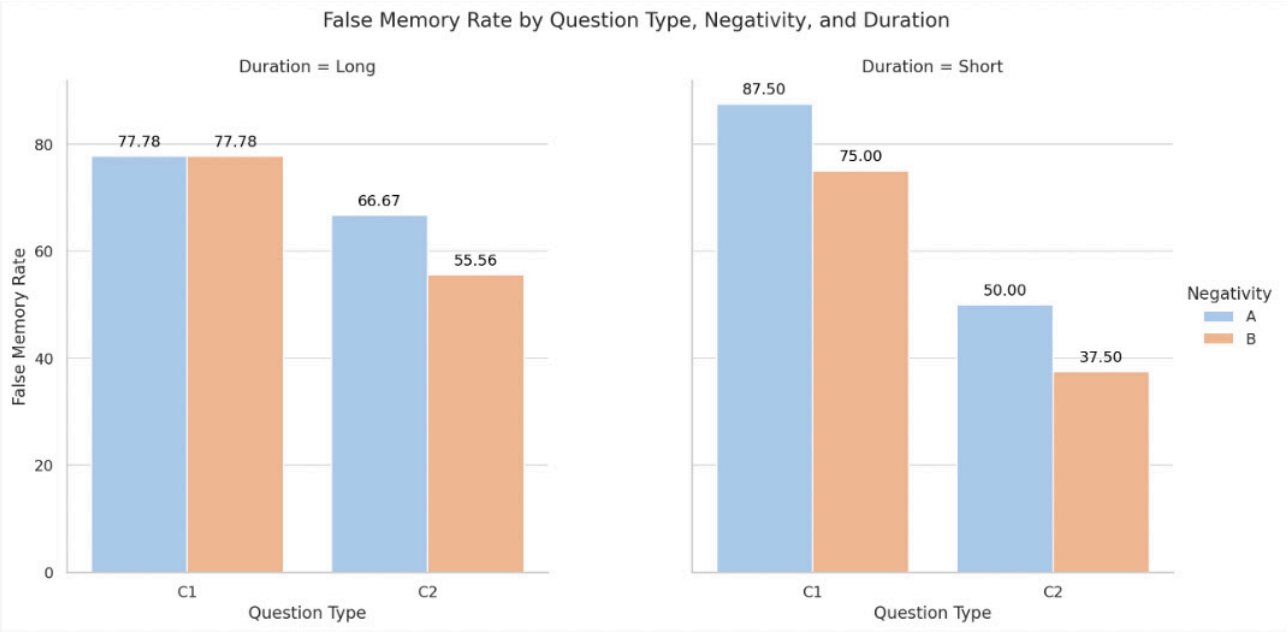
Although no subjects were informed about the confidence test interjected under every multiple-choice question prior to actually seeing it, it did not take too much time to finish since it was simple to understand. In the end, all subjects completed the recognition test without asking any extra questions.

4. Results

4.1 False memory rates by slide type and presentation duration

First, to understand the influence of interconnected independent variables, i.e. within-subjects variables, presence of misinformation (critical vs. non-critical) and negativity of slides (negative vs. neutral), and between-subjects variables, presentation duration (long vs. short), on the formation of false memory, false memory rates were calculated based on different groups.

Table 1 False Memory Rates under the Influences of Question Type, Negativity, and Duration



As shown in Table 1, surprisingly, the false memory rates were 77.78% for both critical (C1) and negative (A) slides and critical and neutral slides (B) in the long presentation group. The former increased to 87.50% for short presentations while the latter slightly decreased to 75.00% for short presentations. On the other hand, for non-critical (C2) and negative slides, the false memory rate was 66.67% for long presentations and dropped to 50.00% for short presentations; for non-critical and neutral slides, the rate was 55.56% for long presentations and further decreased to 37.50% for short presentations.

4.2 Mean confidence levels between artificially and naturallt generated false memory

Another focus of the study was to discern the connection between varying confidence levels and the nature of false memory. The term "false memory" in this study was further defined with 2 branches: artificially generated false memory (the choice "critical lure"), and naturally generated false memory (the choice "foil"), for understanding further in-depth effects. A bootstrapping approach was employed to calculate the mean difference in confidence levels for the groups, mainly because the sample size is too small to form normally distributed data. Therefore, repeating the sampling process 10,000 times could be a way to deal with. Since for non-critical slides, "artificially generated false memory" does not exist, the study narrowed the angle to analyze only critical slides across different duration groups.

Table 2 Bootstrapping Diagram Representing the Confidence Levels for the Two Types of False Memory, Segmented by Critical and negative, Critical and Neutral Slides in the Long group, Critical and Negative Slides in the Short Group

The study enumerated how many of these bootstrapped mean differences were more extreme than the original observations. By dividing this number by 10,000, it can be determined the probability that the results were due to random chance. In the long-duration group, for critical and negative slides, the 95% confidence interval for the difference in means stood at [0.04, 0.38], $p < .05$; according to Table 2, the blue histogram is skewed toward higher confidence levels than the green histogram, indicating that subjects were more confident in their artificially generated false memories. In the same group, but for critical and neutral slides, the 95% confidence interval for the difference in means was [0.44, 0.67], $p < .001$, indicating the same trend. However, in the short-duration group, the blue histogram is skewed towards a lower confidence level; the 95% confidence interval for the difference in means ranged from [-0.70, -0.01], $p < .05$, when the slides were critical and negative, showing that the confidence levels were significantly lower for artificially generated false memories.

5. Discussion

The main objective of this study is to examine the interrelated impacts of presentation duration, negativity of slides, and presence of misinformation in a collective manner after narrowing the research scope into peripheral information in the slides—indeed, the results underscore the necessity of taking into account multiple factors based on the difference in false memory rates.

The most evident finding is that when the question is critical, i.e. misinformation present in the previous questionnaire, subjects' susceptibility is generally higher than when the question is non-critical regardless of the other 2 factors, which shows that the presence of misinformation may be a dominant factor affecting memory of individuals. These results' trend is generally consistent with previous studies that exposure to distorted information can lure people to generate corresponding false memories (e.g. Loftus & Palmer, 1974; Loftus, Miller, & Burns, 1978; Zaragoza & Mitchell, 1996). Additionally, they also align with the previous conclusion made by Loftus (2005) that suggestion-induced distortion in memory is observed among individuals of all ages—in the case that the subjects in this study are all youth and should be supposed to be less susceptible compared to other age groups, e.g. young children or the elderly, as particularly mentioned in that review, but for instance, in the short-duration group, the false memory rate still hit an astounding 87.5%.

Negative slides yielded a higher false memory rate than neutral slides despite the critical negative one in the long group which gained the equivalent rate with the neutral pair. This finding confirms the "trade-off theory" that a cost to peripheral memory will occur when the central information is too overwhelming and brings high emotional intensity (Waring & Kensinger, 2009). In terms of critical neutral and negative questions in the long group, a possible explanation for their equal false memory rate is that the effect of presence of misinformation may be bigger or more dominant than that of negativity, so even though the neutral nature of questions in this pair led subjects to broaden their attention to peripheral details, this extra attention might have been offset by the following misleading information. The conjecture is supported by the previous finding that false memories may persist in spite of the detection of distinctions. According to Loftus and Hoffman (1989), as cited by Loftus (2005), some subjects might keep their memory for the original stimuli but believe that the post-event information is right.

However, in terms of presentation duration, the macro results seem counterintuitive, but the contradicted micro

results are justifiable. To discuss the former, except for the aforementioned critical negative question, the general rates are slightly lower for the short group than for the long group although the shapes are similar; for the latter, interestingly, there was one subject, YS, in the short group reporting "I don't remember anything. Although I noticed the 'correct answers', I still followed my heart and guessed a lot in the end because I wanna be ethical and honest." This is an occasion that is rarely reported in the previous findings but implies that maybe subjects in this group were either guessing or copying the post-event information. Specifically, due to the design of the 10-minute filler activity inspired by Loftus, Miller, and Burns (1978), interjected into the gap between receiving stimuli and receiving misinformation, those in the short group should have shown a much higher false memory rate—supported by the famous third experiment done by Loftus (1978) showing that a long retention interval can make subjects' initial memory fade away, thus being less likely to notice the discrepancies—nevertheless, the study has only 1 detailed explanation for the choices from YS: she chose an option that is either purely "follow" or "guess", so it does not purely stands against the opinion of McCloskey and Zaragoza (1985) that subjects have a high level of distinguishing the original event and the postevent information. In summary, evidence is insufficient to prove the presentation duration has a significant impact on formation of false memory.

Another primary objective of this study was to explore the association of confidence levels with the two different types of false memories. The higher confidence levels associated with artificially generated false memories may be attributed to the misinformation effect (Frenda, Nichols, & Loftus, 2011) since many subjects might believe that the information in the stems must be right. Specifically, for the critical and negative questions in the long group, a high false memory rate was accompanied by a high confidence level for artificially generated false memories, which is consistent with the PNE hypothesis (Porter, Taylor, & Ten Brinke, 2008). However, in the short group, the misinformation effect was likely to be counterbalanced by a high cognitive load (Sweller, 1988), i.e. the task of remembering visual details in an extremely short time. Alternatively, subjects might feel concerned about not remembering anything but choosing the "correct" answer, thus compensating for this mood by choosing a lower confidence level.

6. Evaluation

There are several disadvantages related to the experiment itself. For example, in order to see the significant effects of different presentation durations, it could be better if the difference in durations was bigger—an improved design may be to extend the duration in the long group to 30 seconds as the design made by Porter, Spencer, and Birt (2003). Here the study only extended several seconds on the basis of the "long" duration for viewing words in one DRM experiment (McDermott & Watson, 2001), but it may be unrealistic to juxtapose "words" and "images". Besides, there are few studies investigating this aspect using the misinformation paradigm, so it is probably too rash to choose and let it work with other factors which added complexity to analyze. A better solution may be to separate different independent variables into different experiments.

Additionally, individual differences might be an unexpected extraneous variable. The study used an extremely small sample size, and thus any participant variable will be magnified, which will influence the results. For example, one subject, SR, reported having noticed one discrepancy and realized that the new information was wrong but still chose the foil in the end because she truly thought the creature entangled in the snake was a frog (in fact it is a snake). Indeed, the design of the questionnaire could be more careful next time, but if the study used a large sample size, the results of this subject may only need to be cancelled to minimize extraneous variables. However, in this case, the small sample size does not allow either excluding one's data or generating a more valid pattern of results, not to mention that the generalizability is already weak since the results may only apply to young females in a small area.

Another improvement could be adding an interview. This study can only infer what motivated the subjects to rate their confidence levels and make conclusions based on which, but different people may have different ideas. Take the subject YS for example, if she had not contacted the experimenter after debriefing, it would be still unknown what she thought. Therefore, an interview may be necessary.

7. Summary

The objective of this study is to investigate 2 aspects: the collective impact of presentation duration, negativity (valence), and the presence of misinformation on the development of false memories; the difference of confidence levels when being affected by either naturally or artifiacially generated false memories. It is indicated that exposure to misinformation, namely in the form of critical questions, might increase individuals' susceptibility to developing false memories, especially when slides are negatively valenced. Besides, the long-duration group ex-

hibited significantly higher confidence levels in artificially generated false memories compared to the short-duration group. The findings suggests that both the types of questions asked and the durations of exposure have an impact on the formation of false memories, as well as the confidence levels of individuals in their choice.

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