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RUNNING HEAD: DOCTORED EVIDENCE AND MEMORY

Why do Doctored Images Distort Memory?

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Abstract

Doctored images can cause people to believe in and remember experiences that never occurred, yet the underlying mechanism(s) responsible are not well understood. How does compelling false evidence distort autobiographical memory? Subjects were filmed observing and copying a Research Assistant performing simple actions, then they returned 2 days later for a memory test. Before taking the test, subjects viewed video-clips of simple actions, including actions that they neither observed nor performed earlier. We varied the format of the video-clips between-subjects to tap into the source-monitoring mechanisms responsible for the 'doctored-evidence effect.' The distribution of belief and memory distortions across conditions suggests that at least two mechanisms are involved: doctored images create an illusion of familiarity, and also enhance the perceived credibility of false suggestions. These findings offer insight into how external evidence influences source-monitoring.

Key words: false memory; autobiographical belief; doctored images; fabricated evidence; source monitoring; familiarity; metacognition.

Why do Doctored Images Distort Memory?

Seeing used to be believing, but image-manipulation technology is increasingly blurring the line between fact and fiction. Up to 75% of users on social-networking websites, for instance, enhance photos of themselves before posting them online (Wynne-Jones, 2008) and in recent years many scientific journals have adopted screening procedures to ensure that the images they publish are authentic (Young, 2008). Yet image-manipulation is more than a tool for personal enhancement: doctored images can cause people to believe in and remember experiences that never occurred (see Garry & Gerrie, 2005). In this paper we ask: why are doctored images such an effective form of suggestion? What happens to memory when people encounter fabricated evidence of an event?

The power of fake photographs and videos to foster false memories (hereafter, the *doctored-evidence effect*) is a well-established phenomenon. For instance, Wade, Garry, Read and Lindsay (2002) asked adult subjects to reminisce about the events depicted in four childhood photographs of themselves, one of which had been doctored to show the subject taking a hot-air balloon ride. Although no subjects had ever taken a balloon ride, half of them either described images or false memories of the pseudo-event after repeated interviewing. As well as childhood experiences, other research shows that doctored images can distort memory for recent experiences (Nash, Wade, & Lindsay, 2009). But what are the mechanisms driving the doctored-evidence effect? The Source Monitoring Framework (*SMF*; Johnson, Hashtroudi, & Lindsay, 1993; Lindsay, 2008)—which describes how people attribute mental experiences to reality or to imagination—suggests several mechanisms that could be responsible.

Source Confusions

According to the SMF, memory distortions occur when our mental images of a fictional event are mistaken for memories. Indeed, when our mental images possess the phenomenological qualities we normally associate with memories, such as a feeling of familiarity and rich sensory details, we can struggle to distinguish between imagined and real experiences (Johnson, Foley, Suengas, & Raye, 1988). A SMF account of the doctored-evidence effect suggests that doctored images might distort beliefs and memories via three cognitive mechanisms. First, doctored images might enhance people's feeling of familiarity with the suggested event. Second, doctored images could boost people's ability to vividly imagine relevant details of the event. Third, people might perceive doctored images as highly credible evidence that the suggested event occurred, and so be willing to attribute less familiar or vivid mental images of the event to memory. Any of these three mechanisms—*familiarity*, *imagery* and *credibility*—could play a crucial role in the doctored-evidence effect.

Familiarity. According to the SMF, people sometimes use the familiarity of mental experiences to determine their source. Because real memories typically come to mind rather easily and feel familiar, it is possible to misattribute an unexpected feeling of familiarity when thinking about a fictional experience as being caused by genuine recollection (Jacoby, Kelley, & Dywan, 1989; c.f., the 'availability heuristic', described in Tversky & Kahneman, 1973). In other words, if one experiences a rush of familiarity when an image comes to mind, one may be prone to misattributing the image to memory. Bernstein, Whittlesea and Loftus (2002), for instance, asked subjects to rate their confidence that they experienced various specific events in childhood ("broke a window playing ball"). Some of these events were presented with one keyword in anagram form ("broke a *dwniwo* playing ball"). Bernstein et al.'s subjects reported greater confidence that they had experienced the events presented in anagram form than those presented in regular form. The authors proposed that subjects misattributed the fluency they felt when successfully solving an anagram to actually experiencing the event in childhood. Numerous studies show that images, similarly, can elicit a powerful form of ‘visual fluency’ (Winkielman, Schwarz, Reber, & Fazendeiro, 2003). Therefore, a familiarity account of the doctored-evidence effect predicts that doctored images make suggested events come to mind more readily, and subjects misattribute this feeling of familiarity as remembering.

Imagery. Another cue that people use to determine the source of mental images is the phenomenological characteristics of those images. According to the SMF, real memories typically contain more perceptual and conceptual details than do imagined events, and so imaginations that are rich in these details can be misattributed to memory (Johnson et al., 1988). Along these lines, Lindsay, Hagen, Read, Wade and Garry (2004) found that adult subjects were more likely to develop false memories of a fictional childhood event if they used their school class-photo as a memory aid. The researchers suggested that the class-photos might have provided subjects with visual details of real memories (e.g. what their teacher looked like) that overlapped with the suggested event and enabled subjects to construct detailed mental images that were misattributed as memories. Relatedly, Henkel and Carbuto (2008) showed that real (i.e., non-doctored) photos caused more source monitoring errors than did descriptions of the actions the photos portrayed. Their finding suggests that familiarity alone could not sufficiently account for the photo-induced memory errors, and thus demonstrates that familiarity and imagery are distinct mechanisms. An imagery-based account of the doctored-evidence effect, therefore, suggests that doctored images provide subjects with relevant imagery that overlaps with their other memories from the time of the suggested event and that they could easily confuse with memories.

Credibility. Finally, the SMF posits that people decide whether their mental images are, for instance, vivid or familiar enough to attribute to memory by setting implicit criteria that those images must match. However, it is possible that people might lower their criteria when an event seems likely to have occurred (Mazzoni & Kirsch, 2002). We know that people are more likely to accept misleading information from credible sources than from non-credible sources (Echterhoff, Hirst, & Hussy, 2005; Vornik, Sharman, & Garry, 2003), therefore a credibility-based account suggests that doctored images might cause people to lower their source-monitoring criteria. Put differently, whereas people might typically attribute mental images as memories only when they are highly vivid or familiar, doctored photos or videos might be perceived as highly credible evidence that the suggested event occurred, and consequently lead people to attribute less vivid or familiar mental images as memories.

The present experiment

To investigate which mechanisms underlie the doctored-evidence effect, we adapted Nash et al.'s (2009) procedure for inducing false beliefs and memories of performing simple actions. Subjects were filmed as they observed and copied a Research Assistant (*RA*) performing various actions (e.g., *look under the table; count to twenty*). Later subjects were exposed to a video-sequence comprising clips of actions, including *critical* actions that the subject had neither observed nor performed. We manipulated the format of these video-sequences to create three between-subject conditions that would tap into the mechanisms described above. Specifically, *Self+RA subjects* viewed digitally-manipulated video-clips of themselves ostensibly observing the RA performing critical actions. *RA-Only subjects* viewed video-clips identical to Self+RA subjects, but only saw the RA in the footage and not themselves. *Stranger-Only subjects* viewed video-clips identical to RA-Only subjects, but the actions were performed by a stranger in an unfamiliar room. Finally subjects completed a memory test in which they rated the extent to which they *believed* they performed each action (Belief rating) and their *memory* of performing each action (Memory rating).

Rationale for the manipulation. The distribution of Belief and Memory ratings across conditions should indicate the mechanisms underlying the doctored-evidence effect. If familiarity causes the doctored-evidence effect, then we should expect subjects in all three conditions to exhibit belief and memory distortions. Because all three videos contain clips of some person—either the RA or a stranger—performing critical actions, all three conditions should enable subjects to easily bring to mind (or fluently process) images of the critical actions. This fluent processing should cause illusions of familiarity, which should in turn be misattributed to recollection.

If the imagery provided by doctored video-clips causes the doctored-evidence effect, then we should see more belief and memory distortions among Self+RA and RA-Only subjects than among Stranger-Only subjects. In the Self+RA and RA-Only conditions, the visual details in the video-sequence overlap with the details in subjects' memories of Session 1: they depict the RA who took part in the event and the room where the event happened. Stranger-Only videos, however, contain visual details that conflict with subjects' memories: they show a stranger in a different room. Therefore, if the video-clips help subjects to imagine critical actions, then Self+RA and RA-Only subjects should be more likely to confuse imagined details for memories than Stranger-Only subjects.

Finally, if credibility causes the doctored-evidence effect, then we should see more belief and memory distortions among Self+RA subjects than among RA-Only and Stranger-Only subjects. Because Self+RA videos are the only videos in which subjects see themselves present while critical actions are performed, these clips should be compelling evidence that subjects performed those actions.

In sum, in the present study subjects were exposed to different forms of video-suggestion designed to differentiate between three mechanisms that potentially underlie the doctored-evidence effect.

Method

Subjects and Design

Sixty University of Warwick students and staff members (68% female; $M = 20.73$ years, $SD = 4.54$, Range = 18-41) individually attended two sessions over 3 days and received £6 for participating. The experiment was a mixed design with Critical action type (Video vs. Control) as a within-subjects factor and Video-sequence condition (*Self+RA, RA-Only,* or *Stranger-Only*) as a between-subjects factor. We randomly allocated subjects to video-sequence conditions.

Materials and Procedure

Actions. We used 42 of the simple actions used by Nash et al. (2009, Experiment 2), and selected 4 of these to be our *critical actions* which an independent group of volunteers rated as moderately memorable (Clap your hands; Salute; Click your fingers; Flex your arm)[1]. For each subject, two of these critical actions were randomly assigned as Video actions (i.e., those that subjects would neither observe nor perform, but that would be shown in the video-suggestion), and two were assigned as Control actions (i.e., those that subjects would neither observe nor perform, and that subjects

[1] See Nash et al. (2009) for further details, including mean memorability ratings.

would not be exposed to until the memory test). Of the 38 non-critical actions, subjects observed and performed 26 during Session 1; the remaining 12 were new in the memory test in Session 2.

Session 1: Event

Subjects were informed that the study was investigating mental imagery and that they would be filmed observing and copying the RA performing various actions. The RA and subject sat at a table facing each other, and the remainder of Session 1 was filmed. The RA began by performing a non-critical action for 15 s, the subject then copied the same action for 15 s. Next the RA performed a second action, and so forth until the subject had observed and copied 26 non-critical actions (all subjects performed the same 26 actions in the same order). A loud beep indicated when the subject and RA should start and stop performing each action. Subjects neither observed nor performed any of the four critical actions at any stage. When the subject completed the final action, they were reminded to return 2 days later for Session 2.

Creating the video-sequences. To create the *Self+RA* and *RA-Only* video-recordings, after the subject left the lab the RA filmed herself performing two of the four critical actions (i.e., the Video actions), the selection of which was counterbalanced across subjects. For Self+RA subjects, we doctored these two extra clips by using a split-screen method to combine them with unused clips from other periods of Session 1, in which the subject was observing the RA (see Figure 1 and Nash et al., 2009). The doctored clips therefore ostensibly showed the subject watching the RA perform the critical actions. Next, we inserted the two fake clips into a sequence made up of 10 untouched clips of the subject observing the RA performing non-critical actions.

RA-Only subjects' videos were identical to Self+RA subjects', except that we masked the left half of all 12 clips so that the video only showed the RA. For Stranger-Only subjects, prior to the experiment we created four versions of a standard video-sequence, each version differing only in terms of the two critical actions it contained. For these sequences, we filmed a male volunteer performing non-critical and critical actions in a different room to the location of Session 1 and, as for RA-Only sequences, we masked the left half of each clip.

All subjects saw the same ten non-critical actions in their video, and the two critical actions were in 7th and 10th positions. The twelve clips lasted 10 s each, and were separated by 10-s pauses, thus the sequences lasted 4 min in total.

Session 2: Suggestion and memory test

In Session 2, subjects were seated at a computer and told they would see several video-clips of different actions. The experimenter did not imply that the video-clips were from Session 1 or otherwise. Subjects watched the video-sequence twice through. During the first viewing, subjects wrote down after each clip an estimate of the number of times in the average week they perform the action shown. During the second viewing, subjects wrote down after each clip the name of the action shown. These tasks ensured that subjects attended to each clip. Next, subjects performed a 5-minute anagram-solving filler task. Finally, they completed a surprise memory test comprising the names of 28 actions, including all 4 critical actions (2 Video actions; 2 Control actions), 12 performed actions, and 12 new actions. Subjects rated their *Belief* (1= I definitely did not do this; 8= I definitely did do this) and *Memory* (1= No memory of doing this; 8= Clear and detailed memory of doing this) of performing each action, as per Scoboria, Mazzoni, Kirsch and Relyea's (2004) Autobiographical

Beliefs and Memory Questionnaire. Finally, all subjects were debriefed and invited to attempt to identify which two actions in the video they did *not* perform.

Results and Discussion

Did our video-sequences distort subjects' beliefs and memories? Collapsing our data across all subjects, we found that Video actions were assigned higher Belief [$t(59) = 8.08$, $p < .0001$, $d_z = 1.04$] and Memory ratings [$t(59) = 7.70$, $p < .0001$, $d_z = .99$] than Control actions. Analyzing the data separately for each condition, we found that subjects in *all three* conditions rated Video actions higher than Control actions (Belief, largest $p = .01$, smallest $d_z = .64$; Memory, largest $p = .004$, smallest $d_z = .73$). In other words, just seeing footage of an action being performed was sufficient to cause subjects some uncertainty about whether or not they performed that action, suggesting that a *familiarity* mechanism contributes to the doctored-evidence effect.

We turn now to our main aim: to compare Belief and Memory ratings across the three conditions. To calculate the effect of each type of video upon subjects' beliefs and memories, we subtracted subjects' mean Control ratings from their mean Video ratings. We then used the net differences to compare the effects of the three video-types. Although our initial analyses showed that all three video-types influenced subjects' beliefs and memories, these additional analyses revealed significant differences between the three groups [Belief: $F(2, 57) = 18.88$, $p < .0001$, $\eta_p^2 = .40$; Memory: $F(2, 57) = 14.37$, $p < .0001$, $\eta_p^2 = .34$]. As Figure 2 shows, post-hoc analyses revealed that Self+RA videos were much more powerful than RA-Only and Stranger-Only videos (all ps < .001, all ds > 1.24), suggesting that a *credibility* mechanism also contributes to the doctored-evidence effect. There were no significant differences between the net effects of RA-Only and Stranger-Only videos on either Belief [$t(38) = .07$, $p = .94$, $d = .02$] or Memory [$t(38) = .75$, $p = .46$, $d = .20$]. In other words, increasing the congruence between the imagery in the video-footage and in Session 1—in terms of the room setting or the person who performed the actions—did not increase belief or memory distortion over and above that explainable by a familiarity mechanism. It is also worth noting that there were no significant differences between any of the three groups in terms of ratings for Control actions [Belief: $M_{\text{Self+RA}} = 2.28$; $M_{\text{RA-Only}} = 1.95$; $M_{\text{Stranger-Only}} = 1.95$; $F(2, 57) = .696$, $p = .50$, $\eta_p^2 = .02$; Memory: $M_{\text{Self+RA}} = 1.73$; $M_{\text{RA-Only}} = 1.28$; $M_{\text{Stranger-Only}} = 1.33$; $F(2, 57) = 1.67$, $p = .20$, $\eta_p^2 = .06$].

Recent research has emphasized the importance of distinguishing increases in confidence from actual false beliefs or memories (e.g., Smeets, Merckelbach, Horselenberg, & Jelicic, 2005). How often did our videos induce false beliefs or false memories of performing critical actions, as opposed to just increasing subjects' confidence that they *might* have performed them? To address this question we calculated the number of critical Video and Control actions (out of a possible 2 for each action type) for which subjects assigned a '7' or '8' rating on the Belief and Memory scales. We found that subjects frequently reported false beliefs and false memories of critical Video actions (Figure 3). In particular, Self+RA subjects reported more false beliefs and memories of performing critical Video actions than either other group (Belief: both *p*s $< .001$, both *d*s > 1.84; Memory: both *p*s $< .01$, both *d*s $> .99$). The fact that these distortions occurred within minutes of exposure to the videos further serves to illustrate the power of the doctored-evidence effect.

Finally, many Self+RA subjects expressed surprise when they learnt the video had been doctored ("That's really weird, I didn't even notice!"), and when we asked Self+RA subjects prior to debriefing to guess what the experiment was about, only two suggested a hypothesis involving fake video-evidence.[2] Nevertheless, 60% of subjects across conditions were able to identify both critical Video actions—perhaps unsurprisingly given that they were asked to do so just minutes after seeing the video-sequence. Even so, many subjects expressed uncertainty about their choices, claiming they were making ‘educated guesses’ by eliminating actions that were in the video-sequence but that they recalled more strongly (“It could be ‘Click your Fingers’, although I’m sure I did that one”). If the doctored clips in Self+RA videos had seemed less than authentic, it would be reasonable to expect Self+RA subjects to identify more critical actions than RA-Only or Stranger-Only subjects. Yet Self+RA subjects identified directionally fewer critical Video actions than did the remaining subjects, although these differences were not significant [$M_{\text{Self+RA}}$= 1.4; $M_{\text{RA-Only}}$ = 1.65; $M_{\text{Stranger-Only}}$ = 1.65, $F(2, 57) = 1.33$, $p = .27$, $\eta_p^2 = .04$]. Together these findings suggest that most Self+RA subjects were unaware of the trickery and that their memory test responses cannot be attributed to demand effects.

Alternative accounts of the present findings

Although the primary cause of the doctored-evidence effect appears to be a credibility mechanism, two alternative interpretations of our findings warrant further discussion. The first is that the extra details in Self+RA (and, indeed, RA-Only) videos could enhance the familiarity of these video-clips over Stranger-Only clips. As such, a familiarity mechanism alone might account for our pattern of findings. In fact, we have some evidence that the extra visual details did indeed boost familiarity. We analyzed subjects’ ratings for the 6 truly performed non-critical actions that were both in the video-sequences and the memory test. In line with the familiarity account, Belief ratings for these actions increased from Stranger-Only (M = 7.35), to RA-Only

[2] Removing these subjects from analyses did not change the pattern of findings.

(M = 7.77), to Self+RA (M = 7.93) subjects [F(2, 57) = 5.05, p < .01, η_p^2 = .15]. The same was true of Memory ratings, although these differences were not significant [Stranger-Only, M = 7.02; RA-Only, M = 7.40; Self+RA, M = 7.50; F(2, 57) = 1.58, p = .21, η_p^2 = .05]. Looking closer at these data, the extra detail in RA-Only (compared to Stranger-Only) videos was sufficient to increase subjects' Belief ratings for the 6 non-critical actions (p = .07), despite having no effect upon their ratings for critical Video actions (in fact, the difference fell in the opposite direction, p = .94). Put differently, although we detected that familiarity increased between these two conditions, this increase did not influence subjects' critical action ratings. This finding suggests it is unlikely that the extra detail in Self+RA (compared to RA-Only) videos can explain the very high critical Video ratings in the Self+RA condition. Further research, though, should explore the effects of different imagery—such as images of oneself—upon familiarity-based recollection.

A second interpretation of our results is that an imagery account might best describe the effectiveness of Self+RA videos, because they helped subjects to mentally picture their own appearance. If this were the case, Self+RA videos ought to equally help subjects to picture themselves performing *any* action, including actions that were not in the video. In line with this reasoning, Self+RA subjects' Control ratings were directionally higher than those of the other two groups, suggesting that these subjects' Video ratings may too have been boosted by their enhanced ability to imagine themselves. Yet because our analyses comparing the three conditions are based upon the mean difference between Video and Control ratings, the effect of enhanced imagery of oneself ought to be cancelled-out from these analyses. As such, although the self-imagery account is relevant, it cannot explain the pattern of findings depicted in Figure 2.

Conclusions

Doctored images appear to be so effective at distorting beliefs and memories because as well as increasing at least one memory-like quality of people's mental imagery (i.e., its familiarity), they also cause people to accept lower levels of memory-like qualities when attributing images of the suggested events as memories (i.e., due to their credibility).

The results of the present study help to support and refine Mazzoni and Kirsch's (2002) model of autobiographical beliefs and memories. Specifically, Mazzoni and Kirsch proposed that people might lower their criteria for attributing as memories their images of events that seem highly likely to have occurred. Our results provide strong support for this proposal. Specifically, Self+RA subjects—who saw themselves in the video-evidence—gave much higher ratings for Video actions than did the remaining subjects. The enhanced familiarity and imagery caused by seeing footage of oneself appear insufficient to have caused these large effects; the best explanation therefore, is that Self+RA subjects adopted lower source monitoring criteria because the evidence was simply so credible. Our data therefore offer a deeper understanding of the role of external evidence—as opposed to internal cognitive processes (Wade & Garry, 2005)—in source-monitoring. Of course, our results do not rule out the possibility that vivid imagery (and indeed familiarity and credibility) might be more important in different circumstances. For instance, when there is a long delay between exposure to the false images and the memory test, or when the suggested event supposedly occurred in the more distant past, perceptually-detailed mental imagery might be more influential. A full account of the doctored-evidence effect, therefore, may need to be sensitive to these and other situational factors.[3]

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[3] We thank an anonymous reviewer for this observation.

On a practical level, the effects of false evidence are especially pertinent to the interrogation of criminal suspects. One reason is that certain types of forensic evidence, such as fingerprint-matches, have considerable potential to be unreliable (Dror & Charlton, 2006; Moore, 2009). Another reason is that police investigators in many parts of the world are legally permitted to present suspects with fabricated evidence to elicit a confession. False evidence, it appears, might cause innocent suspects to falsely confess, internalize guilt, and perhaps falsely recall the guilty act (Gohara, 2006; Kassin & Gudjonsson, 2004; Nash & Wade, 2009), and the present study offers further support for the case that credible yet false evidence can distort beliefs and memories. Suspects, investigators, and anyone else, therefore, should be wary of memories that suddenly surface after exposure to event-confirmatory evidence.

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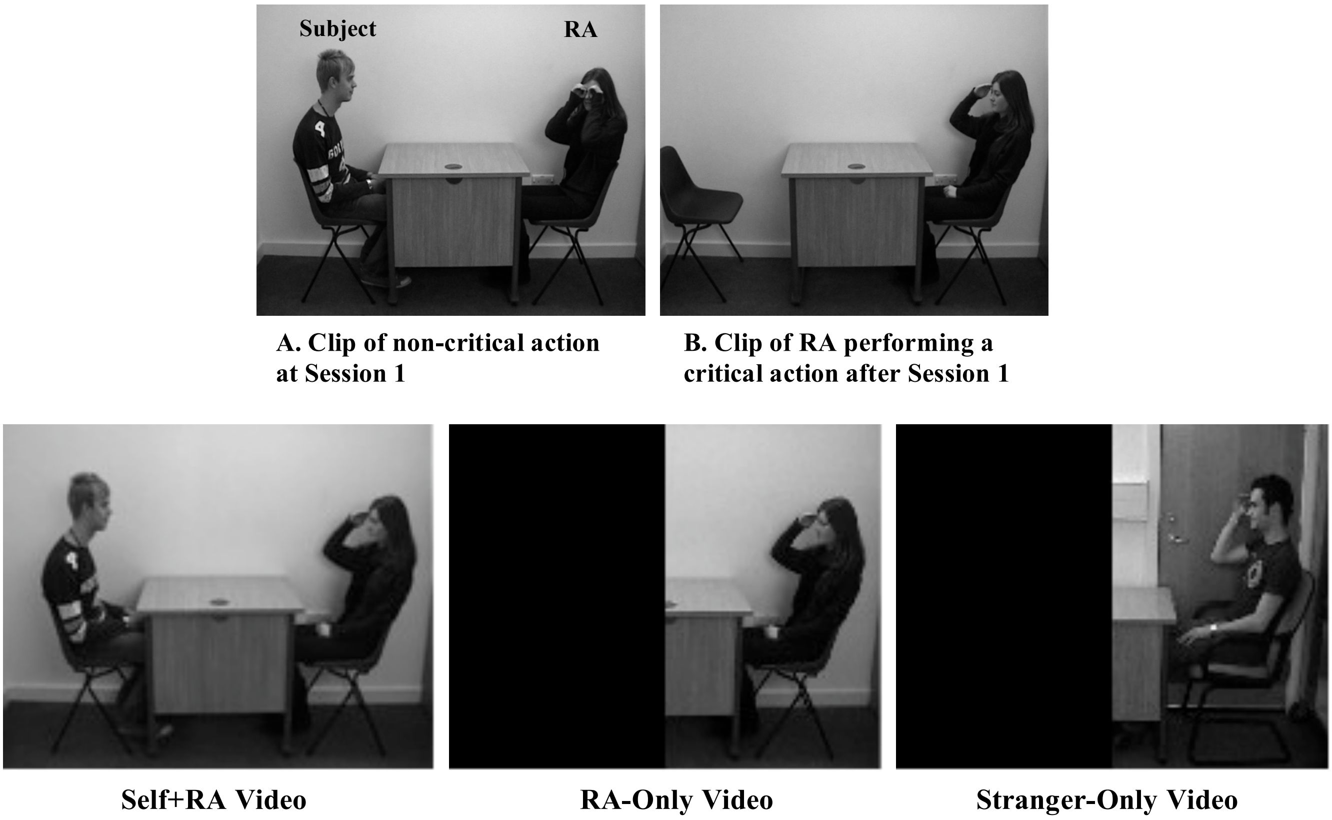
Figure Captions

Figure 1. Creating the critical video clips. The top row shows untouched footage filmed (A) during Session 1 and (B) immediately after Session 1. The bottom row shows the three types of critical clips. Self+RA clips were created by combining (A) and (B); RA-Only clips were created using right-half of (B); Stranger-Only clips were created prior to experiment.

Figure 2. Mean effect of each type of video upon subjects' Belief and Memory ratings for critical actions (Mean Video ratings minus mean Control ratings). Error bars represent 95% confidence intervals.

Figure 3. Percentage of critical actions to which subjects assigned ratings of 7 or 8 on the Belief (i.e, false beliefs) and Memory (i.e., false memories) scales.



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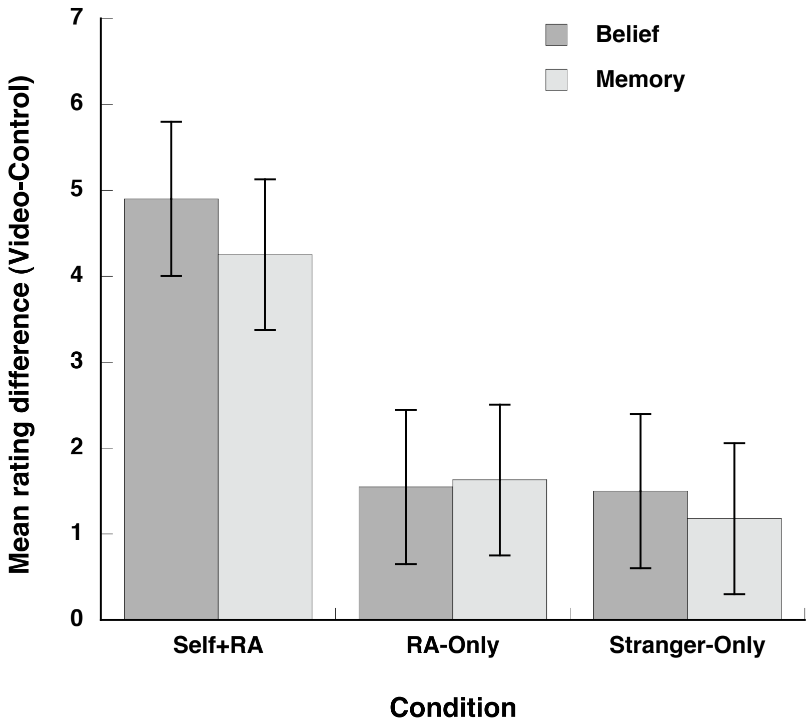

Figure 2. *Mean effect of each type of video upon subjects' Belief and Memory ratings for critical actions (Mean Video ratings minus mean Control ratings). Error bars represent 95% confidence intervals.*

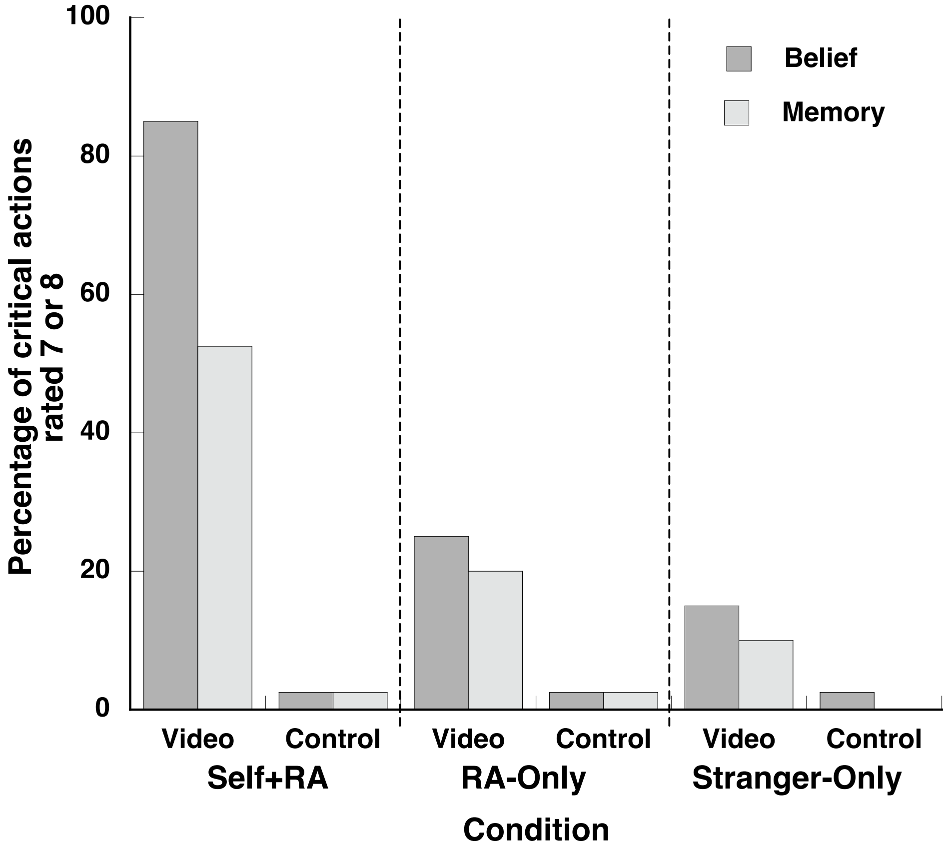

Figure 3. *Percentage of critical actions to which subjects assigned ratings of 7 or 8 on the Belief (i.e, false beliefs) and Memory (i.e., false memories) scales.*