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Believing Does Not Equal Remembering:
The Effects of Social Feedback and Objective False Evidence on Belief in Occurrence, Belief in Accuracy, and Recollection

Henry Otgaar[1,2,3], Jianqin Wang[1], Jan-Philipp Fränken[1], & Mark L. Howe[1,3]

[1]Maastricht University, The Netherlands

[2]Faculty of Psychology, Universitas Indonesia

[3]City, University of London, UK

Correspondence should be sent to: Henry Otgaar, Henry.Otgaar@maastrichtuniversity.nl, Faculty of Psychology and Neuroscience, section Forensic Psychology, Maastricht University.

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Abstract

We examined the impact of social feedback and objective false evidence on belief in occurrence, belief in accuracy, and recollection of an autobiographical experience. Participants viewed six virtual scenes (e.g., park) and were tested on their belief/recollection. After 1-week, participants were randomly assigned to four groups. One group received social feedback that one scene was not experienced. A second group received objective false evidence that one of the scenes was not shown. A third group received both social feedback and objective false evidence and the control group did not receive any manipulation. Belief in occurrence dropped considerably in the social feedback group and in the combined group. Also, nonbelieved memories were most likely to occur in participants receiving both social feedback and objective false evidence. We show that social feedback and objective false evidence undermine belief in occurrence, but that they leave belief in accuracy and recollection unaffected.

Keywords: Autobiographical Memory; Nonbelieved Memory; Belief; Recollection

Believing Does Not Equal Remembering: The Effects of Social Feedback and Objective False Evidence on Belief in Occurrence, Belief in Accuracy, and Recollection

We are sometimes faced with a situation in which our memory is put into doubt. We might be told that our memory is incorrect or be presented with evidence (e.g., a photograph) suggesting that our memory is wrong. The crucial question then is whether such manipulations might affect our autobiographical memories. In the current experiment, our aim is to show that such manipulations can have a unique effect on autobiographical memory. Specifically, we will show that such manipulations can decrease people's belief that the autobiographical event occurred while simultaneously leaving the recollection (i.e., feeling of re-experiencing) intact, a memory phenomenon also called nonbelieved memories (see for a review, Otgaar, Scoboria, & Mazzoni, 2014).

The aim of the current experiment falls under the overarching theme of research on differences between judgments of belief and recollection (Scoboria, Jackson, Talarico, Hanczakowski, Wysman, & Mazzoni, 2014). In general, when memory researchers talk about autobiographical memory, they refer to the entire experience of recalling events that happened to one's self. An important component of this experience is recollection which involves the reliving and re-experiencing of an event. Belief in *occurrence* and belief in *accuracy* are two other important components of an experience and are distinct metacognitive appraisals that are made about an event. Belief in occurrence refers to the truth value attributed to the occurrence of an event, whether the event is recollected or not. Belief in accuracy refers to the appraisal that the details recalled about an event correspond to how the event in fact unfolded in the past.

These ideas on the role of belief and recollection within autobiographical memory are related to how people decide whether a mental representation is a memory or not based on metacognitive attributions of mental experiences during remembering. Specifically, the source monitoring framework refers to determining the source of our memories by relying on specific characteristics of our mental experiences (Johnson, Hashtroudi, & Lindsay, 1993). For example, when our mental experiences contain on average many perceptual and affective details, we attribute that mental experience as a memory for an experienced event while if our mental experience reflects more cognitive operations, that mental experience will be likely to be attributed to an internally-derived event (e.g., imagination). Likewise, Rubin's (2006) Basic Systems model posits that belief in accuracy and recollection both contribute to autobiographical remembering and that each reflects different metamemorial processes.

Research shows that belief in occurrence, belief in accuracy, and recollection all contribute to remembering and for many of our memories for events, we have a strong sense of recollection of those events, believe that the events happened, and believe that our memories accurately depict the past (Scoboria, Talarico, & Pascal, 2015). Indeed, although in many experiences, recollection and belief (in occurrence) are both present, such as recollecting and believing that your last birthday party happened, in other situations, recollection is absent, but belief is intact such as believing that you were born. In more exceptional cases, it is even possible to form so-called nonbelieved memories in which people have memories of an event which they no longer believe took place (Mazzoni, Scoboria, & Harvey, 2010; Otgaar, Scoboria, & Mazzoni, 2014). For example, Scoboria and colleagues (2014) found that visual details and the feeling of re-experiencing a mental representation predicted recollection, but not belief in occurrence, whereas event plausibility strongly predicted belief in occurrence and only weakly

predicted recollection. Belief in accuracy and recollection also seem to arise from different underlying mechanisms. Here, it has been found that for believed memories, recollection and belief in accuracy were strongly correlated, while this correlation was much weaker for nonbelieved memories.

Nonbelieved Memories

Research on nonbelieved memories shows that belief in occurrence and recollection are independent constructs. The first empirical study on nonbelieved memories was performed by Mazzoni and colleagues (2010). In this retrospective study, participants were asked – among other things – whether they could report a nonbelieved memory and describe the reasons for why they stopped believing in the occurrence of the event. About 20% of the participants reported having such a nonbelieved memory. Of importance for the current experiment, the participants provided several reasons for the reduction in belief (in occurrence) including social feedback by others, changes in the perceived plausibility of the experience, and being confronted with contradictory evidence.

Having established that nonbelieved memories can be found in a considerable minority of participants, researchers became interested in whether nonbelieved memories could be experimentally induced in the laboratory. In one study, the false memory implantation procedure (Loftus & Pickrell, 1995) was used to elicit nonbelieved memories (Otgaar, Scoboria, & Smeets, 2013). Adults (Experiment 1) and children (Experiment 2) were falsely told that they were on a hot air balloon ride as a young child. After two follow-up suggestive interviews, participants were debriefed and told that the event was fabricated. Following this disclosure, participants had to rate their belief (in occurrence) and recollection for the fictitious event. It was found that 40% of those with implanted false memories reported a nonbelieved memory after the debriefing.

Clark, Nash, Fincham, and Mazzoni (2012) used doctored video clips to evoke false memories and subsequently told participants about that these clips were doctored. More specifically, participants were presented with doctored video clips suggesting that they performed actions while in fact they did not. After producing false memories, participants were told about the fabrication of the video clips and had to provide belief in occurrence and recollection ratings for performed and not-performed actions. The authors found that belief ratings decreased to a larger degree than recollection ratings and that debriefing concerning the doctored clips created nonbelieved memories.

Whereas the previously-mentioned experiments focused on creating nonbelieved memories by informing participants about the falsity of their *false* memories, studies have also revealed that nonbelieved *true* memories can be formed. For example, Mazzoni, Clark, and Nash (2014) also used the doctored video approach but now to examine the effect of social feedback on memory for genuinely performed actions. Specifically, they told participants that authentic video clips of participants performing actions were in fact fabricated in order to undermine belief and recollection for true experiences. Paralleling previous work (Clark et al., 2012), belief in occurrence ratings were reduced to a greater extent than autobiographical recollection ratings.

Furthermore, in two recent studies (Otgaar, Scoboria, Howe, Moldoveanu, & Smeets, 2016), adults (Study 1) and children (Study 2) were involved in an adapted version of the imagination inflation procedure for actions (Goff & Roediger, 1998). Participants imagined, performed, and heard action statements (e.g., break the tooth pick). During a second session, they had to imagine certain actions repeatedly, and two weeks later received a recognition test. For a randomly selected set of actions that were recollected by participants as being performed and were indeed performed, participants received social feedback stating that the actions were

originally not performed. In both studies, for up to about a third (Study 1) and a half (Study 2) of the challenged actions, belief in occurrence or recollection was relinquished (see for a similar study: Scoboria, Otgaar, & Mazzoni, 2018).

What these studies clearly show is that social feedback is an important agent in undermining belief for experienced and non-experienced events. Also, the available evidence suggests that belief in occurrence is impacted more by social feedback than is autobiographical recollection. The finding that social feedback via debriefing or challenges can produce nonbelieved memories aligns well with research on the reasons that participants come up with for explaining why they stopped believing in the occurrence of autobiographical events.

Reasons to Withdraw Belief

The first study assessing the reasons that participants give for relinquishing belief in occurrence was the previously mentioned study by Mazzoni and colleagues (2010). The reasons that participants gave for belief reduction could be categorized in three themes. The first and most often reported category referred to other people telling the participants that the memory was incorrect (e.g., a parent might say that the event actually happened to another family member). A second category included events that were deemed too implausible to have occurred (e.g., recalling seeing a living Dinosaur). A third category involved contradictory evidence concerning the remembered events (e.g., finding a photograph challenging whether you experienced a certain event).

Scoboria, Boucher, and Mazzoni (2015) asked participants to report having a nonbelieved memory and to state the reasons for why belief in occurrence was relinquished. Here too, major categories that were mentioned were social feedback, implausibility of events, and objective

false evidence. However, other categories were also present such as characteristics of the memory (e.g., feelings that the memory was unusual) that made participants doubt the memory.

Theoretically, the work on the reasons for withdrawing belief in occurrence is closely connected to strategies that people use to verify their memories (Wade & Garry, 2005; Wade, Nash, & Garry, 2014). What this work has shown is that participants primarily rely on other people to verify whether their memories are correct. The main motive for choosing this strategy is that by relying on other people represents a rather cheap and easy way to verify your own memories. This might explain why social feedback has been shown to be the key reason underlying people's retraction of their belief in the occurrence of events.

The Current Experiment

In the current experiment, we experimentally examined to what extent social feedback and objective false evidence might affect belief in occurrence, belief in accuracy, and recollection. There are several reasons for why we decided to look at the separate and combined effects of social feedback and objective false evidence on belief in occurrence, belief in accuracy, and recollection. Although social feedback has been used in previous work to examine its impact on belief in occurrence and recollection, objective false evidence has not. Objective false evidence such as photographs has been well researched in the area of false memory. This work has shown that photographs can increase the susceptibility to false memory formation (e.g., Lindsay, Hagen, Read, Wade, Garry, 2004; Otgaar, Candel, Merckelbach, & Wade, 2009; Wade, Garry, Read, & Lindsay, 2002). However, what happens when memories are contradicted by objective false evidence is unknown. Indeed, as Scoboria and Pascal (2016, p. 1075) noted "more research is needed to understand what happens when vivid memories are confronted with contradictory evidence." Furthermore, by examining both social feedback and objective false

evidence, we can investigate which one is most likely to reduce belief in occurrence, belief in accuracy, and recollection. Based on previous research (e.g., Otgaar et al., 2013) social feedback is likely to impact belief in occurrence but at this moment, it is not obvious whether it will impact belief in accuracy and recollection as well. Furthermore, in contrast to social feedback, objective false evidence is likely to affect belief in accuracy because by receiving objective false evidence suggesting that a memory is incorrect, participants might reappraise the accuracy of their memory for the event.

In the present experiment, participants were involved in several autobiographical experiences. Specifically, by using virtual reality, participants experienced six different virtual scenes (e.g., going to a pub). After experiencing these scenes, participants had to provide belief in occurrence, belief in accuracy, and recollection ratings. After a 1-week interval, participants in the control group had to provide the same ratings once more. The other participants received social feedback, objective false evidence, or a combination suggesting that one of their memories was incorrect and then were asked to provide belief in occurrence, belief in accuracy, and recollection ratings again. As can be seen, our focus is on examining whether our manipulations might affect belief in occurrence, belief in accuracy, and recollection for experienced events, an area of nonbelieved memories that is still quite under-researched. Our hypothesis was that the number of nonbelieved memories would be greater in the group that received a mixture of social feedback and objective false evidence and that all three experimental groups would have more nonbelieved memories than the control group, suggesting that the combination of social feedback and objective false evidence leads to the highest drop in belief.

Method

Participants

The current experiment was preregistered at AsPredicted (https://aspredicted.org/gc269.pdf). Using G*Power (Faul, Erdfelder, Lang, & Buchner, 2007) with an estimated medium effect size ($f = 0.3$), a power of 0.80, and an alpha of 0.05, 128 participants were needed for the four conditions. The participants ($N = 130$) were first year psychology students (86 female) (*mean age* = 21.62, $SD = 4.30$, range: 18-52). Participants received course credits or a financial reimbursement (7.50€). The study was approved by the Ethical Review Committee of the Faculty of Psychology and Neuroscience, Maastricht University. All data are available on the Open Science Framework (https://osf.io/6kmvt/).

Materials

Virtual Reality Scenes. Eight virtual scenes were included in the experiment. These scenes were selected based on a pilot study ($n = 15$, mean age = 20.67, $SD = 2.06$, range: 18-25; 8 males) assessing the familiarity (7-point Likert scale; 1 = not familiar at all, 7 = highly familiar) and distinctiveness (7-point Likert scale; 1 = not distinctive, 7 = distinctive) ratings of each scene. In general, we found that all scenes were quite similar to each other in terms of distinctiveness and familiarity. We did find that the alley scene ($M = 4.20$, $SD = 1.86$) was rated less familiar than the city square scene ($M = 6.07$, $SD = 0.96$, $p = .02$) and that the pub scene ($M = 3.87$, $SD = 1.06$) was less distinctive than the park scene ($M = 5.53$, $SD = 1.19$, $p = .04$). However, because participants received a random sequence of six of these eight scenes and were randomly challenged on one of these scenes, these small differences did not matter. The scenes used in the present experiment included the environment of an office, a train station, a park, a pub, a fast-food restaurant, an airport, an alley, and a square (see Appendix). All participants

were exposed to a selection of six random scenes from the total of eight. The scenes were presented in random order to all participants. We used the NVIS ST-50 virtual reality hardware and Vizard 5 as virtual reality software.

Ratings. Belief in occurrence and accuracy and recollection ratings were measured in the current study on a 7-point Likert scale (i.e., belief in occurrence ("How likely is it that you personally did in fact experience [virtual scene]?"): 1: Not at all – 7: Completely; belief in accuracy ("How confident are you that your memory for this [virtual scene] is accurate?"): 1: Not at all – 7: Completely, recollection ("Do you actually remember experiencing [virtual scene]?"): 1: No at all – 7: Completely). The belief in occurrence and recollection ratings were taken from the Autobiographical Memory and Belief Questionnaire (Scoboria, Mazzoni, Kirsch, & Relyea, 2004) and the belief in accuracy ratings were adopted from recent research by Scoboria and colleagues (Scoboria & Talarico, 2013; Scoboria et al., 2015). Additionally, vividness, spatial layout, and visual details of the experience were measured using the same type of Likert scale which was adopted from the Memory Characteristics Questionnaire (Johnson, Foley, Suengas, & Raye, 1988). Two additional filler items were included, assessing the similarity and ability to interact with the experienced scene, but the findings will not be discussed in the present manuscript.

Design and Procedure

The current experiment used a 4 (Condition: Social feedback, Objective false evidence, Combination, Control) x 2 (Time: Session 1 vs. Session 2) mixed design with condition as between-subjects factor. Participants were randomly assigned to one of four different conditions: control (n = 34), social feedback (n = 32), objective false evidence (n = 32) and combined social feedback with objective false evidence (n = 32).

Two sessions were conducted over a 1-week period. Session 1 was about experiencing an autobiographical event using virtual reality and making ratings about the event a day later. During Session 2, participants' belief in occurrence, belief in accuracy, and recollection concerning the virtual event were challenged. Participants were tested individually in a virtual reality lab. The entire experiment lasted approximately 1 hour.

Session 1. Participants were told that they would participate in an experiment assessing memory. Oral and written instructions about the procedure were provided by the researcher and participants received additional information about the risks of virtual reality (e.g., feelings of dizziness). After receiving instructions on how to use the equipment, participants signed the informed consent. Thereafter, participants were positioned in the experimental set-up and walked through six different virtual scenes. All scenes were recorded and later used for the subsequent manipulations. Each scene lasted approximately 25 seconds. During each scene, participants were instructed to walk slowly to a red dot in front of them. While walking to the dot, participants were instructed to pay attention to the environment making sure that they were able to encode as many details as they could from the scene. On arrival at the red dot, participants had to turn around and wait for the next scene to start. The same instructions applied for all six scenes. After completion, participants were told that they would receive an online questionnaire assessing belief in occurrence, belief in accuracy, and recollection of the events after one day and that they had to complete the questionnaire before midnight of the same day. Specifically, they had to complete these ratings in the following order: recollection, belief in accuracy, belief in occurrence, two filler items, vividness, visual details, and spatial layout. One picture of each VR scene was included to remind the participants of which scenes had been presented to them.

Session 2. After 1-week, all participants were tested once more in the lab. Depending on their condition, participants received different instructions. Participants in the control condition completed belief in occurrence, belief in accuracy, and recollection ratings of the experienced events once more. All other participants were first confronted with feedback and/or objective false evidence suggesting that they did not experience one of the six scenes in Session 1. For each of these participants, the target scene that was challenged was randomly selected. In the social feedback condition, the experimenter provided verbal feedback and suggested to the participants that they made an error in the answers they provided in the online questionnaire filled out the week before. Instead of experiencing the selected target scene, the experimenter told the participant that they had experienced a different scene, one they initially did not experience. This suggested scene was randomly selected from the two remaining scenes that were not included in the recordings of Session 1. The exact instruction was: "*As I watched the video recordings of your virtual reality experience, I saw that there was actually a difference between your answers in the questionnaire and the video recordings. I saw that you did not go through the [virtual scene] but you filled in that you went through the [virtual scene]. Instead, you went through the [virtual scene] landscape. I walked you through the landscapes and I am very confident about which landscapes you went through. We also noticed that it is a bit harder for almost everyone to differentiate between environments that are similar to each other, for example, the airport and the train station. A lot of people mix up these environments in their memory.*"

In the objective false evidence condition, participants were told that the landscapes were recorded that they walked through on the first day and that they would see them. Specifically, participants were exposed to a doctored video showing the original recordings of Session 1 and

one randomly selected scene replaced the target scene. In the combined feedback and evidence condition, participants received both suggestive feedback and the doctored recordings. They first received the suggestive feedback and were then shown the doctored video. Afterwards, all participants from these three conditions completed several ratings in the following order (recollection, belief in accuracy, belief in occurrence). The same online questionnaire was used again but no pictures of the scenes were included and each scene was prompted by naming the scene in the rating questions (e.g., "Do you actually remember experiencing the scene of a park?"). Participants received a debriefing via email after all participants were tested.

Results

Deviations from Protocol

In the preregistration, we only focused on the effect of social feedback and objective false evidence on belief *in occurrence* and recollection. In the current results section, we have also reported analyses on *belief in accuracy.* Furthermore, we used a chi-square analysis on the number of nonbelieved memories which is a better way to analyze the data instead of using the planned analysis (ANOVA). Furthermore, in line with previous studies (e.g., Mazzoni et al., 2014), we also looked at nonbelieved memories in which recollection ratings were 2 points or higher than belief in occurrence ratings.

Belief in Occurrence, Accuracy, and Recollection

We used JASP (version 0.8.4) and SPSS to analyze our data. One participant of the combined group did not provide ratings at the second session leading to a final sample of N = 129. We conducted a 4 (Condition: Social feedback, Objective false evidence, Combination, Control) x 2 (Time: Session 1 vs. Session 2) mixed ANOVA on the belief in occurrence ratings of the challenged scene. A statistically significant interaction was found ($F(3,125) = 6.29$, $p <$

.001, $\omega^2 = 0.08$). Simple effect analyses showed the following. At Session 1, the different groups did not vary in terms of belief in occurrence ratings ($F(3,126) = 0.26$, $p = .85$, $\omega^2 = 0.08$, see Table 1). However, when we looked at the belief in occurrence ratings at Session 2, we found a statistically significant Condition effect ($F(3,125) = 9.99$, $p < .001$, $\omega^2 = 0.17$). To examine whether this effect is more in line with the alternative than null hypothesis, we calculated a Bayes Factor with a default prior of 0.71 (Wagenmakers et al., 2018). We found a BF_{10} of 3215.15 which suggests that this effect favors the alternative hypothesis (i.e., differences between the conditions).

Follow-up planned contrasts revealed that the social feedback and the combination group had statistically lower belief in occurrence ratings than the control group (*p*s < .001; Cohen's *d* = 0.95 and 1.31, respectively). Furthermore, we found that the combination group had statistically lower belief in occurrence ratings than the objective false evidence group ($p = .01$, Cohen's $d = 0.57$). When we focused on the belief in accuracy and recollection scores, no statistically significant effects emerged (all *p*s > .05).

Nonbelieved Memories

We also identified the number of nonbelieved memories for the scene that was challenged at Session 2. We used the same criterion employed in previous research in which recollection ratings needed to be at least 2 scale points higher than belief in occurrence (e.g., Mazzoni et al., 2014) and within this criterion, recollection ratings should be at least 3 or higher. For believed memories, recollection ratings should be at least 3 and belief in occurrence should be equal to, or 1 point above 3. If belief in occurrence ratings were 2 points higher than recollection ratings, we coded this as believed, not remembered events. Furthermore, if

recollection ratings and belief in occurrence ratings were very small (≤ 2), we coded this a not-believed, not-remembered event.

Based on this, we found 50 nonbelieved memories, 66 believed memories, 5 believed not-remembered events, and 8 not-believed not-remembered events. To examine whether the number of these different memory types differed as a function of Condition, we conducted a Condition x Memory Type χ^2 analysis (see Table 2). The analysis detected a statistically significant effect ($\chi^2(9) = 31.21$, $p < .001$, Cramer's $V = 0.49$). Interestingly, follow-up analyses using a Bonferroni correction (0.05/16 tests) showed that statistically more nonbelieved memories ($n = 20$) were formed than the other memory types (believed memories ($n = 9$), believed not remembered ($n = 0$), not-believed not-remembered ($n = 2$)) in the group that received both social feedback and objective false evidence ($p < .001$). Furthermore, it was found that more believed ($n = 28$) and fewer nonbelieved memories ($n = 3$) were likely to occur in the control group than the other memory types (both ps $< .001$).

As planned, we also looked at the number of nonbelieved memories when recollection ratings were 1 scale points higher than belief in occurrence ratings. Based on this criterion, we found 68 nonbelieved memories, 46 believed memories, 8 believed not-remembered events, and 7 not-believed not-remembered events. A χ^2 analysis showed again that Condition and Memory Type were statistically related to each other ($\chi^2(9) = 36.77$, $p < .001$, Cramer's $V = 0.31$). Specifically, nonbelieved memories ($n = 26$) were more often found in the group receiving both social feedback and objective false evidence than in the control group ($n = 7$; $p < .001$) and the group receiving only objective false evidence ($n = 13$; $p = .002$). This effect was not statistically significant when the number of nonbelieved memories in the combined group was compared

with the number of nonbelieved memories in the group receiving social feedback (n = 22; p = 0.24).

We also looked at the number of nonbelieved memories after Session 1. For 1 scale point difference, we found: 42 nonbelieved memories, 60 believed memories, 18 believed, not-remembered events, and 10 not-believed, not-remembered events. For 2 scale points difference, we found: 16 nonbelieved memories, 100 believed memories, 7 believed, not-remembered events, and 7 not-believed, not-remembered events. We also explored whether after Session 1, more nonbelieved memories were present in the group receiving social feedback and objective false evidence than in the other groups. This was not the case when the 1 scale point difference was applied ($\chi^2(9) = 3.58$, p = .94, Cramer's $V = 0.10$) and this effect was also not statistically significant with the 2 scale points difference ($\chi^2(9) = 13.75$, p = .13, Cramer's $V = 0.19$)

Exploratory Analyses

Vividness, Visual Details, and Spatial Lay-out. We did not find any statistically significant effects of Condition and Session on vividness, visual details, and spatial layout for the challenged scene (all ps > .05).

Covariate Analyses. An alternative way to analyze the data is by treating the Session 1 data for belief in occurrence, belief in accuracy, and recollection as a covariate. We conducted 3 separate ANCOVAs on belief in occurrence, belief in accuracy, and recollection with Session 1 data as covariates and Condition as a between-subjects variable. We found that the covariates had a statistically significant effect on our dependent variables (all ps < .05). More importantly, we found identical results as those obtained with the repeated measures data above. That is, Condition had no impact on recollection ($F(3,124) = 0.71$, $p = 0.55$, $\omega^2 = 0.00$), but did effect belief in occurrence ($F(3,124) = 9.94$, $p < 0.01$, $\omega^2 = 0.16$). Furthermore, we now also found that

Group had a statistically significant effect on the belief in accuracy ratings, although the effect was small ($F(3,124) = 2.74$, $p = 0.046$, $\omega^2 = 0.03$). Post-hoc Bonferroni comparisons showed that the group that received both social feedback and objective false evidence had lower belief in accuracy scores than the control, but this difference was not statistically significant (see Table 1; $p = .06$).

Correlational Analyses. Because recollection, belief in occurrence, and belief in accuracy seem to arise from different mechanisms (Scoboria et al., 2014), we explored, for the challenged scene, correlations between recollection, belief in accuracy, vividness, and visual details before and after the manipulation as a function of Memory Type. Because the number of believed not-remembered events and not-believed not-remembered events was very low at both sessions (ns ≤ 8), we will not discuss the correlations for these memory types. However, for believed and nonbelieved memories, we found at both sessions that recollection, belief in accuracy, vividness, and visual details were statistically significantly correlated with each other (rs > 0.50, ps $< .03$; see Table 3). For Session 2, we also examined whether the correlation between belief in accuracy and recollection differed statistically between believed and nonbelieved memories. In order to do this, we applied a Fisher r-to-z transformation (using this site: http://vassarstats.net/rdiff.html) to look at the statistical significance between the two correlation coefficients. No statistically significant effect was found ($z = 1.60$, $p = 0.11$, two-tailed).

Other Virtual Reality Scenes. The findings reported above were conducted on the challenged scene. To examine whether our manipulations uniquely affected the challenged scene and not the other scenes, we conducted several 4 (Condition: Social feedback, Objective false evidence, Combination, Control) x 2 (Time: Session 1 vs. Session 2) repeated measures

ANOVAs on the following variables: belief in occurrence, belief in accuracy, recollection, vividness, visual details, and spatial layout. Specifically, the dependent variables referred to the means of all scenes at Session 1 and the means of all scenes, excluding the challenged scene, at Session 2. For all of these analyses, we did not find any effect of Condition on any of the dependent variables (all *p*s > .05). We did find higher ratings at Session 2 than Session 1 for belief in occurrence, vividness, visual details, and spatial layout ratings (see Table 4).

Discussion

The principal aim of the current experiment was to examine the impact of social feedback and objective false evidence on belief in occurrence, belief in accuracy, and recollection. Our findings are quite straightforward. As predicted, we found that belief in occurrence ratings were considerably lower in the social feedback group and for participants that received both social feedback and objective false evidence than for participants in any of the other groups. Furthermore, we found that nonbelieved memories were most likely to occur in participants receiving a mixture of social feedback and objective false evidence. Finally, our results showed that our manipulations had a strong impact on undermining belief in occurrence.

In the current experiment, participants underwent a virtual reality experience in which they were shown six different virtual reality scenes (e.g., park). The goal of using these virtual reality scenes was to provide participants with a wide variety of autobiographical experiences which is oftentimes more difficult to accomplish using "real" autobiographical experiences. The use of virtual reality in memory research is becoming increasingly more frequent as it offers a rather simple and efficient way to study autobiographical memory functioning (e.g., Huff, Hernandez, Fecteau, Zielinksi, Brady, & LaBar et al., 2011; Schöne, Wessels, & Gruber, in

press). That is, the level of immersion in virtual reality experiences is quite similar with how people experience autobiographical events in real life. However, questions remain as to whether virtual reality scenes are as self-relevant as "real" autobiographical experiences which might be seen as a limitation of using virtual reality scenes (Schöne et al., in press).

After being immersed in the virtual reality scenes, participants received a memory test in which they had complete belief in occurrence, belief in accuracy, and recollection ratings for the experienced scenes. After 1-week, participants returned to the lab and, depending on the condition, could be exposed to different manipulations. Specifically, participants could be suggestively told that one of the events was not experienced, received objective false evidence that the event did not occur, a combination of both, or received nothing. As mentioned before, participants were less likely to believe that the challenged event had been experienced when they received social feedback or a combination of feedback and evidence than participants in the other groups.

This finding mirrors previous research showing that social feedback undermines belief in occurrence (e.g., Clark et al., 2012; Otgaar et al., 2016) and aligns with research on the reasons that people report for why they retracted belief in occurrence (e.g., Scoboria et al., 2015). Furthermore, we found that the group that received additional objective false evidence evinced even lower belief in occurrence ratings than the other groups. However, the group that only received objective false evidence did not differ from the control group in terms of belief of occurrence. This finding suggests that social feedback is the main factor in affecting the belief that people pose in the occurrence of events and that this effect can be increased by adding "objective" evidence regarding the non-occurrence of events. This latter suggestion echoes our finding that nonbelieved memories were most likely to be created when social feedback *and*

objective false evidence were presented. As such, we have presented the first demonstration that for vivid autobiographical experiences elicited by virtual reality scenes, it is relatively easy to create nonbelieved memories.

The result that objective false evidence might provide an additional decrement in belief in occurrence is not that surprising. A wealth of research has shown that objective false evidence such as photographs boost the formation of false beliefs and false memories (e.g., Lindsay et al., 2004; Wade et al., 2002). It has to be noted though that in these studies, oftentimes the inclusion of objective false evidence was done in combination with a suggestive interview as was the case in our experiment as well. This suggests that the objective false evidence seems to act as some sort of extra verification of the trustworthiness of social feedback. In that sense, this experiment parallels studies showing that to verify one's own memories, people frequently use cheap and easy strategies such as relying on someone else compared to solely resorting to objective evidence (Wade et al., 2014).

Our exploratory analysis provided some evidence that belief in accuracy was affected by our objective false evidence, although the effect size was small. Indeed, when we conducted an exploratory analysis including Session 1 as a covariate, we found some support that belief in accuracy scores were lower in the combined group than in the control group. In previous studies using doctored materials (e.g., Clark et al., 2012), the experienced event was manipulated and it is clear that when such fake evidence is provided, participants might doubt whether their memory is an accurate reflection of the event. However, we did not manipulate anything within a particular virtual reality event. Instead, we deleted one experienced scene and replaced it with a non-experienced one. So, when participants were shown which virtual scenes they experienced (including a non-experienced scene), there were few reasons to reappraise the accuracy of the

memories of these scenes, but nonetheless, this manipulation affected belief in accuracy to some extent. Future studies could provide stronger manipulations of objective false evidence. It might well be the case that with stronger forms of objective false evidence, both social feedback *and* objective false evidence might have equal effects on belief in occurrence and belief in accuracy. So, although our study shows that social feedback seems to impact belief in occurrence more than objective false evidence, this might be related to manipulations used in the current experiment. These differences might become smaller with objective false evidence that is much stronger in nature.

Another notable finding was that our manipulations predominantly affected belief in occurrence. On the one hand, this underscores research showing that belief in occurrence, belief in accuracy, and recollection are distinct metamemorial processes that contribute to the act of remembering (Scoboria et al., 2015). On the other hand, this result clearly shows that belief in occurrence is inherently receptive to social demands and more so than recollection. This latter aspect is especially interesting as past research has demonstrated that our memory is extremely malleable and that suggestive interviews might lead to false autobiographical memories (Scoboria et al., 2016). However, the current results imply that belief in occurrence is perhaps more responsive to social and suggestive pressure than recollection (Scoboria et al., 2014). Support for our findings can also be seen in the analyses on autobiographical memory performance and phenomenology of the other scenes. That is, we first specifically focused on the impact of our manipulations on autobiographical memory for the challenged scene. When we examined this performance for the other scenes, we found that our manipulations did not affect the unchallenged scenes and hence uniquely affected memory for the challenged scene.

An additional interesting observation was that belief in occurrence, belief in accuracy, visual details, vividness, and recollection were highly positively related to each other. These correlations even emerged for both believed and nonbelieved memories. Why this is interesting is because Scoboria and Pascal (2016) found that the relationship between belief in accuracy and recollection was weaker for nonbelieved memories than for believed memories. Presumably, when confronted with contradictory information (e.g., social feedback, objective false evidence), belief in accuracy will cease to appraise the event as accurately occurring in the past while visual imagery is said to continue to support recollection even when belief is undermined. We also found some evidence that the relationship between belief in accuracy and recollection became smaller after belief in occurrence was undermined. However, we did find that even for nonbelieved memories, the correlation between belief in accuracy and recollection was high. Of course, the study by Scoboria and Pascal (2016) was about already existing memories occurring to the self in the past that participants had to retrospectively rate on belief and recollection. In the current study, aside from being "virtual" autobiographical memories, the induced memories were rather recent than the ones reported by Scoboria and Pascal. Because our study involves more recently occurring memories, it is likely that participants are more confident that their mental representations are an accurate reflection of what happened than in the study by Scoboria and Pascal and that therefore it is more difficult to change belief in accuracy.

One potential limitation of the current experiment is that although our objective false evidence manipulation did not involve any direct suggestive or social pressure to the participants, the manipulation was provided within the social context of the experiment. This might explain why belief in occurrence dropped in participants receiving both social feedback and objective false evidence. This aligns well with previous research in which belief in occurrence decreased

when participants were told their memories were incorrect (i.e., social feedback) by simultaneously presenting them with fake objective false evidence (e.g., Clark et al., 2012; Mazzoni et a., 2014). Future research might attempt to better separate objective false evidence from the social context of the experiment. This could be achieved by not letting the experimenter present the objective false evidence to the participants and by making sure a computer program automatically presented the evidence to participants.

Another possible caveat is whether participants were able to understand the difference in rating belief in occurrence and belief in accuracy. Although the instructions to rate these forms of belief were quite different from each other (see Materials), in general, people might have difficulty when distinguishing between the two forms of belief. However, we argue that there might be situations in which these forms of belief are distinguished. Consider this hypothetical scenario: You went with a friend to an expensive restaurant. After a week, you retell your memory of this event to your friend stating that you enjoyed the red wine that was served during the main course. Your friend, however, argues that white wine was served instead of red wine. In this hypothetical scenario, you might still believe that the event occurred, but you believe less in how accurate you remember the details of this event. The reverse might occur as well. You might have a vivid memory of going to a theme park when you were a child. When talking about this with your parents, they state that this never happened when you were a child. In this situation, you might start to believe less in occurrence of the event when you were a child, but perhaps because you went to this theme park when you were older, you still have a strong belief in the accuracy of the remembered details (e.g., remembering which attractions there are).

To summarize, in the current experiment, we showed that belief in occurrence was likely to decrease when social feedback indicating that a virtual scene was not observed was provided

to participants. Furthermore, adding additional objective false evidence to the social feedback in the form of a doctored video in which a previously observed scene was omitted produced a larger effect on occurrence ratings.

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Table 1. *Means and standard deviations (in parentheses) of recollection, belief in occurrence, belief in accuracy ratings as a function of Condition and Session*

		Recollection	Belief in Occurrence	Belief in Accuracy
Session 1	Control	5.85 (2.03)	5.68 (1.95)	5.44 (1.78)
	Social Feedback	5.72 (1.92)	5.31 (2.01)	5.22 (1.88)
	Objective false evidence	5.69 (1.94	5.63 (1.66)	5.22 (1.95)
	Combination	6.03 (1.53)	5.50 (1.55)	5.56 (1.52)
Session 2	Control	5.85 (1.94)	5.44 (2.03)	5.44 (1.88)
	Social Feedback	5.53 (1.50)	3.41 (2.24)	4.41 (1.95)
	Objective false evidence	5.47 (2.17)	4.56 (2.15)	4.91 (2.05)
	Combination	5.48 (1.46)	2.87 (1.89)	4.32 (2.12)

Table 2. *Number of different memory types as a function of Condition*

	Believed memories	Nonbelieved memories	Believed, not remembered events	Not-believed, not-remembered events
Control	28	3	1	2
Social Feedback	11	18	2	1
Objective false evidence	18	9	2	3
Combination	19	20	0	2

Table 3. *Correlations between recollection, belief in accuracy, vividness, visual details as a function of Memory Type and Session for the challenged scene*

			Belief in Accuracy	Vividness	Visual details
Session 1	Believed memory	Recollection	0.81**	0.47**	0.43**
		Belief in accuracy		0.50**	0.51**
		Vividness			0.81**
	Nonbelieved memory	Recollection	0.66**	0.77**	0.54*
		Belief in accuracy		0.74**	0.65**
		Vividness			0.86**
Session 2	Believed memory	Recollection	0.71***	0.62***	0.59***
		Belief in accuracy		0.68***	0.71***
		Vividness			0.87***
	Nonbelieved memory	Recollection	0.52***	0.62***	0.67***
		Belief in accuracy		0.48***	0.67***
		Vividness			0.85***

* Correlation is significant at 0.05 level, ** Correlation is significant at 0.01 level, *** Correlation is significant at 0.001 level

Table 4. *Means (standard deviations in parentheses), F-values, p-values, and effect sizes of belief in occurrence, vividness, visual details, and spatial layout*

	Mean (SD) Session 1	Mean (SD) Session 2	*F*-value	*p*-value	ω^2
Belief in occurrence	4.63 (0.81)	5.73 (4.95)	6.12	0.02	0.04
Vividness	3.60 (0.73)	4.44 (3.84)	5.73	0.02	0.04
Visual details	3.38 (0.73)	4.18 (3.27)	6.94	0.01	0.05
Spatial layout	3.57 (0.77)	4.39 (3.45)	6.57	0.01	0.04

Appendix

Screenshots of the different virtual reality scenes

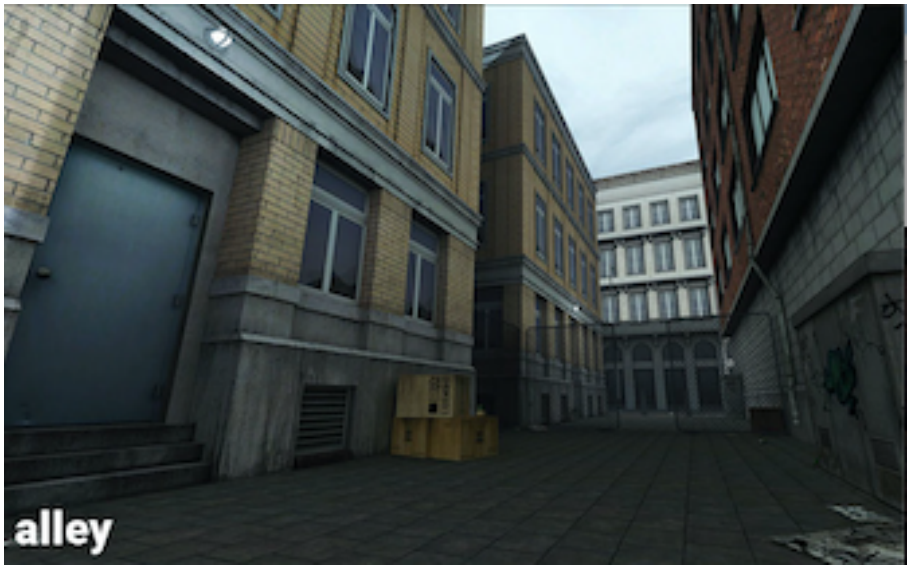

park


pub


KLM
airport


fastfood


square


alley