Rich false memories of autobiographical events can be reversed

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False memories of autobiographical events can create enormous problems in forensic settings (e.g., false accusations). While multiple studies succeeded in inducing false memories in interview settings, we present research trying to reverse this effect (and thereby reduce the potential damage) by means of two ecologically valid strategies. We first successfully implanted false memories for two plausible autobiographical events (suggested by the students' parents, alongside two true events). Over three repeated interviews, participants developed false memories (measured by state-of-the-art coding) of the suggested events under minimally suggestive conditions (27%) and even more so using massive suggestion (56%). We then used two techniques to reduce false memory endorsement, source sensitization (alerting interviewees to possible external sources of the memories, e.g., family narratives) and false memory sensitization (raising the possibility of false memories being inadvertently created in memory interviews, delivered by a new interviewer). This reversed the false memory build-up over the first three interviews, returning false memory rates in both suggestion conditions to the baseline levels of the first interview (i.e., to ∼15% and ∼25%, respectively). By comparison, true event memories were endorsed at a higher level overall and less affected by either the repeated interviews or the sensitization techniques. In a 1-y follow-up (after the original interviews and debriefing), false memory rates further dropped to 5%, and participants overwhelmingly rejected the false events. One strong practical implication is that false memories can be substantially reduced by easy-to-implement techniques without causing collateral damage to true memories.

false memory | suggestion | reversibility | long-term effects

Until he was 14, Jean Piaget vividly recollected an attempt to kidnap him at a young age: "I was held in by the strap fastened round me while my nurse bravely tried to stand between me and the thief. She received various scratches, and I can still see vaguely those on her face. Then a crowd gathered, a policeman with a short cloak and a white baton came up and the man took to his heels. I can still see the whole scene, and can even place it near the tube station" (1). One year later, however, Piaget's former nurse confessed that she had made up the whole story.

Contrary to common belief (2–5), vivid recollections such as the one reported by Piaget can be entirely false. That is, they may describe an event that never actually happened. To date, much psychological research has demonstrated that our memory does not at all resemble a recorder but is reconstructive in nature (6) and potentially fallible (7–10) and malleable (11–13). The most impressive evidence for this comes from studies implanting false memories of entire events that never happened in children (14–17) as well as adults (18–28). A recent "mega-analysis" (29) of several studies on false memories concluded that 30% of all 423 participants had developed false memories; another 23% developed false beliefs only (i.e., believed that the suggested, fictitious event had actually taken place without, however, experiencing recollections), and 47% developed neither a false memory nor belief. In other words, about half of the participants could be persuaded to incorporate an event into their autobiographical memory that never happened. The enormous relevance of this becomes immediately apparent in the forensic context: Believing, or even remembering, something that never happened may lead to false confessions (30–32) as well as false allegations (33–35). Moreover, estimates of the real-life prevalence of false memories as well as retrospective analyses of exoneration cases clearly suggest that these are not rare occurrences (36–38). In police interrogations or legal proceedings, it is therefore of the utmost importance to discriminate authentic from false memories and ideally empower the interviewee to retract the latter.

While remedies are urgently needed, systematic research on how to undo or reverse implanted false autobiographical memories has been scarce. Specifically, previous attempts at reversing false memories have been limited in two important respects: First, they involved mostly small and peripheral details of observed events [i.e., using the eyewitness misinformation paradigm (39)] or laboratory-produced mini-events [such as clicking one's fingers (40)], both of which lack the embeddedness of autobiographical memories within the person's life story. Second, almost all of these studies used reversal techniques that are impossible to implement or highly implausible in the real world, such as positively telling participants that some events had merely been suggested or even identifying those events (15, 16, 39–45). This not only requires privileged knowledge on the part of the investigator but also creates a highly targeted response set in participants (i.e., trying to positively identify the false events) that is unlikely to be transferable to real-world settings. Lastly, existing real-world evidence stemming from individuals who later retracted

Significance

Human memory is fallible and malleable. In forensic settings in particular, this poses a challenge because people may falsely remember events with legal implications that never actually happened. Despite an urgent need for remedies, however, research on whether and how rich false autobiographical memories can be reversed under realistic conditions (i.e., using reversal strategies that can be applied in real-world settings) is virtually nonexistent. The present study therefore not only replicates and extends previous demonstrations of false memories but, crucially, documents their reversibility after the fact: Employing two ecologically valid strategies, we show that rich but false autobiographical memories can mostly be undone. Importantly, reversal was specific to false memories (i.e., did not occur for true memories).

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a belief or memory due to their conviction that it was false [i.e., retractor reports (46, 47)] is anecdotal and lacks crucial information about ground truth. In summary, systematic research on how rich false autobiographical memories can be reversed in the real world is virtually nonexistent, though urgently needed.

Here, we present a systematic attempt to undo false memories of autobiographical events. As this requires the antecedent creation of false memories, the first part of this study consisted of interviews designed to elicit false memories. Following previous procedures (27), we recruited participants for a study on "childhood memories" and sent their parents questionnaires detailing the purpose of the study but asking them not to tell their children, who were likewise instructed not to talk about the study with their parents. Parents indicated for a number of negative events (see https://osf.io/ser63/ for the full list) whether or not their child had experienced them and additionally suggested two negative events that did definitely not happen to their children but were plausible. Participants were then invited to three successive memory interviews (with a lag of 1 wk between each interview) and asked to recollect four events from their childhood—the two plausible but not experienced (false) events (e.g., getting lost, running away, being involved in a car accident, injuries, being the perpetrator or victim of material damage) and two actually experienced (true) events (see https://osf.io/ser63/ for the full interview protocol).

Different from prior research (22, 27, 28), our interviewer was completely blind to the study design and the status of each event (true or false) in order to rule out interviewer effects (48–54) and to increase ecological validity. We further extended previous research in two ways. First, we contrasted two suggestion conditions (minimal versus massive suggestion) in order to separately capture the effect of using massively suggestive techniques in addition to the basic effect of establishing rapport and informing participants that their parents had told us about the events (in the minimal suggestion condition); these elements have mostly been conflated in previous research. Second, in a comprehensive assessment of our reversal procedure, we analyzed not only recollections of false events but also true events. After all, even a perfectly effective reversal procedure in terms of undoing false memories would be of little value if it likewise led to the retraction of true memories [i.e., made people generally skeptical of their recollections (45, 55)]. Importantly, including true memories also enabled truly blind coding of participants' memory reports (independent coders did not know the truth status of the recollections they were categorizing).

Our reversal attempts consisted of two sensitization strategies that were ecologically valid in the sense that they 1) can principally be implemented in the real world and 2) do not require knowledge about the truth status of the memories. They were employed successively and immediately following the third memory interview. The first strategy (source sensitization) involved reminding participants that memories may not always be based on people's own experience but also on other sources (e.g., family narratives about an event, a photograph, etc.) and involved asking them to specify the source of each of their recollections. This addresses one of the mechanisms underlying the development of false memories, source misattributions (56–58) (see https://osf.io/ser63/ for verbatim instructions). Moreover, it allows us to precisely identify recollections that participants explicitly endorse as their own (false) memories.

The second strategy (false memory sensitization) was inspired by the enlightenment technique (59), a type of postwarning that has been successfully used to reverse the eyewitness misinformation effect (39, 45) and stereotype effects on memory (60) and involved alerting participants to the possibility of false memories while trying to avoid a general response bias. To this end, we told participants that repeatedly cueing recollections involves some risk of inadvertently producing false memories and asked them to revisit their event memories with this possibility in mind and to let us know if they thought this applied to one or more of the events they reported (while emphasizing that there was no automatic expectation that it would). Furthermore, to emulate an important real-life context, these instructions were delivered by a new interviewer who asked the participants to imagine she was an expert witness with no knowledge about the previous interviews and trying to critically review the remembered events (see https://osf.io/ser63/ for verbatim instructions). In summary, the

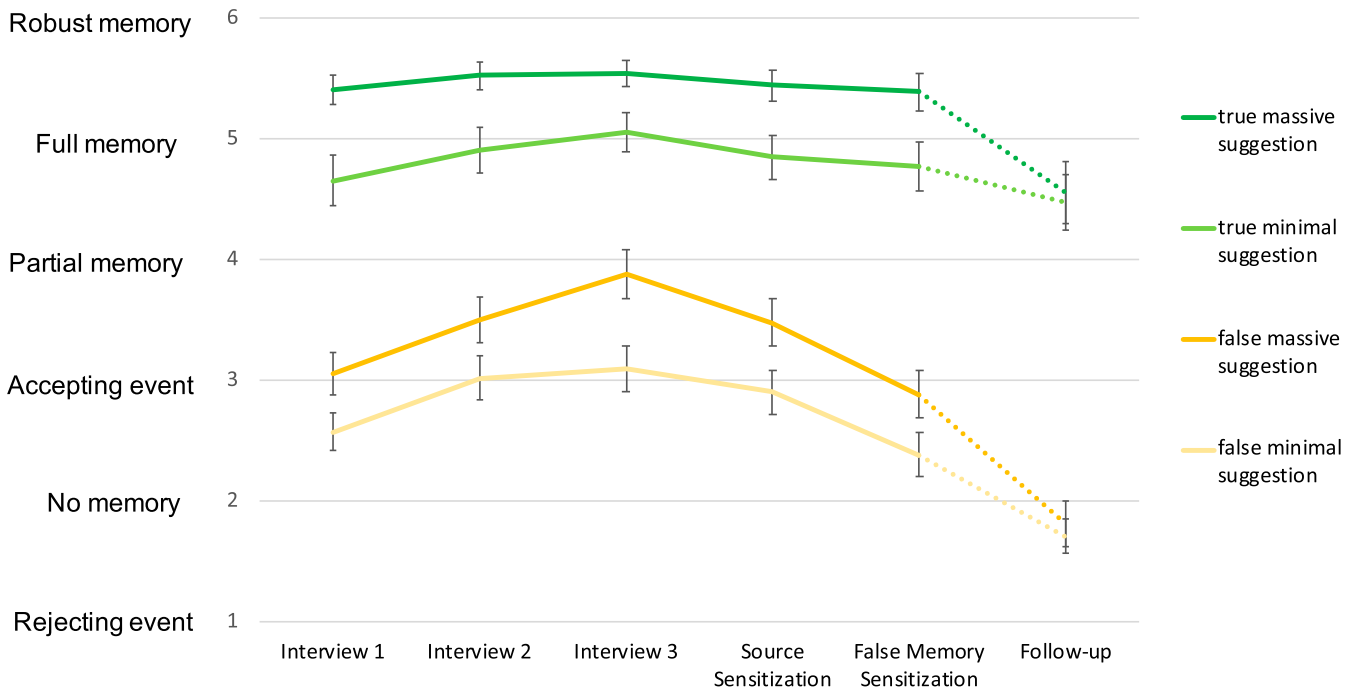

Fig. 1. Average classification of participants' memory reports as a function of measurement occasion (1 through 3, after source sensitization, after false memory sensitization, follow-up), event type (true, false), and suggestion condition (minimal, massive). Error bars represent SEs.

rationale behind this strategy was to 1) raise participants' awareness of the possibility of false memories, 2) urge them to critically reflect on their recollections, 3) facilitate false memory identification by reducing the uncertainty the initial suggestion had elicited, 4) strengthen participants' trust in their own perspective, and—through the new interviewer—5) lower the social costs associated with memory retraction (61–63). As preregistered (see *Methods*), we expected both strategies to significantly reduce false memories without exerting the same influence on true memories.

Results

Did We Effectively Induce False Memories? We first tested a necessary precondition for false memory reversal—that false memories had been induced and consolidated in the initial interviews. We analyzed memory reports for false events across Interviews 1 through 3, rated by two coders on a memory quality scale used in previous research (29) but slightly adapted for the present purposes (see below). As displayed in Fig. 1 (orange lines), memory quality increased across the first three interviews ($F(1.238, 102) = 25.327$, $P < 0.001$, $\eta_p^2 = 0.332$), from means around 3 (representing mere belief in/acceptance of the event) to means closer to 4 (representing at least partial false memory). Furthermore, using massive suggestion led to higher overall levels of false memory ($F(1, 51) = 9.859$, $P = 0.003$, $\eta_p^2 = 0.162$) but not to a steeper increase in (false) memory quality over time ($F(1.518, 102) = 2.698$, $P = 0.086$ for the interaction).

When true events were included in the analysis, a main effect of event type (true or false) indicated that memory quality was generally (and unsurprisingly) higher for true events ($F(1, 51) = 114.170$, $P < 0.001$, $\eta_p^2 = 0.691$, green lines in Fig. 1). More interesting, a significant interaction of event type, measurement occasion, and suggestion emerged ($F(1.730, 102) = 5.762$, $P = 0.006$, $\eta_p^2 = 0.102$). A breakdown showed that true and false events were similar in their development over time in the minimal suggestion interviewing condition ($F(1.554, 102) = 0.987$, $P = 0.358$), but this trajectory differed significantly in the massive suggestion condition ($F(1.758, 102) = 15.829$, $P < 0.001$, $\eta_p^2 = 0.237$); false events increased significantly in memory quality across interviews ($F(1.492, 102) = 22.977$, $P < 0.001$, $\eta_p^2 = 0.311$), but true events remained rather stable ($F(1.662, 102) = 2.608$, $P = 0.088$). That is, massive suggestion produced additional effects over time compared with the mere assertion that the events happened.

Breaking down (false) memory quality into distinct levels in a separate analysis (Fig. 2), we found that 27% and 56% of participants in the minimal and massive suggestion conditions, respectively, developed false memories (partial to robust) for the false event after 2 wk (Interview 3). Furthermore, coded false memory quality was generally (i.e., across interview conditions and times) meaningfully related to recollective experience (e.g., participants' self-rated amount of sensory information, rs = 0.427 to 0.645, Ps < 0.003; clarity/vividness of the recollection, rs = 0.530 to 0.631, Ps < 0.001; participants' confidence, rs = 0.529 to 0.640, Ps < 0.001; there were only two exceptions, both in the first minimal suggestion interview: clarity/vividness, $r = 0.217$, $P = 0.192$, and confidence, $r = 0.233$, $P = 0.158$).

Could We Reverse False Memories after the Fact? To examine if the source sensitization and false memory sensitization procedures led to a reversal of false memories, we compared (false) memory quality across the last three measurement occasions (Interview 3, source sensitization, false memory sensitization) and found the predicted decrease across measurements ($F(1.740, 102) = 44.732$, $P < 0.001$, $\eta_p^2 = 0.467$). Specifically, (false) memory quality decreased significantly from Interview 3 to the source memory test ($P < 0.001$, $\eta_p^2 = 0.223$) and further after false memory sensitization ($P < 0.001$, $\eta_p^2 = 0.548$) (see Fig. 1, orange lines). Recollections elicited with massive suggestion remained higher in (false) memory quality than those with minimal suggestion ($F(1, 51) = 8.066$, $P = 0.006$, $\eta_p^2 = 0.137$), but the temporal trajectory was similar ($F(1.563, 102) = 2.005$, $P = 0.150$, for the interaction). Fig. 2 shows the proportions of participants who continued to report false memories (partial to robust) after source sensitization (minimal suggestion: 21%, massive suggestion: 42%) and after false memory sensitization (minimal suggestion: 15%, massive suggestion: 23%).

Was This Reversal due to General Memory Skepticism? To see if the reduction of false memories came at the expense of participants generally doubting their recollections and therefore also questioning their memories for actually experienced events, we looked at recollections of true events as well. Although true memory quality decreased slightly after source sensitization ($F(1, 51) = 5.829$, $P = 0.019$, $\eta_p^2 = 0.103$) and further after false memory sensitization ($F(1, 51) = 7.696$, $P = 0.008$, $\eta_p^2 = 0.131$), true and false memories were still differentially affected by the reversal procedure, as predicted and reflected in a strong event × measurement occasion interaction ($F(1.652, 102) = 28.416$, $P < 0.001$, $\eta_p^2 = 0.358$). Specifically, the decrease in memory quality was significantly more pronounced for false memories (Fig. 1). That is, our reversal procedures did have a slight impact on true events as well, but the false memory reversal cannot be reasonably attributed to general memory skepticism.

Reversal or Only Reduction? The absence of a realistic baseline measure before applying some minimal suggestion (i.e., before claiming that parents had told us about the event) makes it difficult to decide if false memories have been reversed in an absolute sense or merely reduced. Conceivably, if participants had been asked before the study whether or not any of the events proposed by the parents had happened to them, or if they remembered anything along these lines, the false memory incidence would have been lower—although we cannot be sure by how much (it may not necessarily be zero, given that the parents had proposed the false events on the basis of plausibility for their child).

Therefore, the best available baseline in the context of our study remains the false memory level at Interview 1 in the minimal suggestion condition (i.e., at the first measurement occasion and without any further suggestive intervention). Pairwise comparisons showed that (false) memory quality did not differ from this value after our two reversal strategies had been applied—neither after minimally (t (51) = 1.02, $P = 0.31$, $d = 0.14$) nor after massively suggestive interviews (t (51) = 1.23, $P = 0.22$, $d = 0.17$). Furthermore, within both the minimal and massive suggestion conditions, participants showed descriptively less endorsement of their false memories at the last compared to the first measurement occasion (Fig. 1). That is, the false memory buildup over the 2 wk interview period reverted back after source and false memory sensitization to the baseline level that was obtained before (massive) suggestion techniques were (repeatedly) applied.

Long-Term Effects? False information provided in the context of psychological research may have long-term effects despite thorough debriefing (64), and false memories have partly survived their discrediting in other research (15, 40, 65, 66). To explore the persistence of false event memories in our young adult participants after source sensitization, false memory sensitization, and debriefing, we invited them back for a follow-up interview more than a year (mean [M] = 390.71 d; range = 277 to 485; SD = 63.28) after the original study (see below for details). Not all original participants attended, but the subsample who did (see *Methods*) was statistically indistinguishable from those who did not (as measured by their scores at the end of the original study, Ps > 0.227).

Memory quality ratings for true and false memories at follow-up are shown in Fig. 1. Overall, the ratings are lower than in the original study but particularly so for false memories. Note, however,

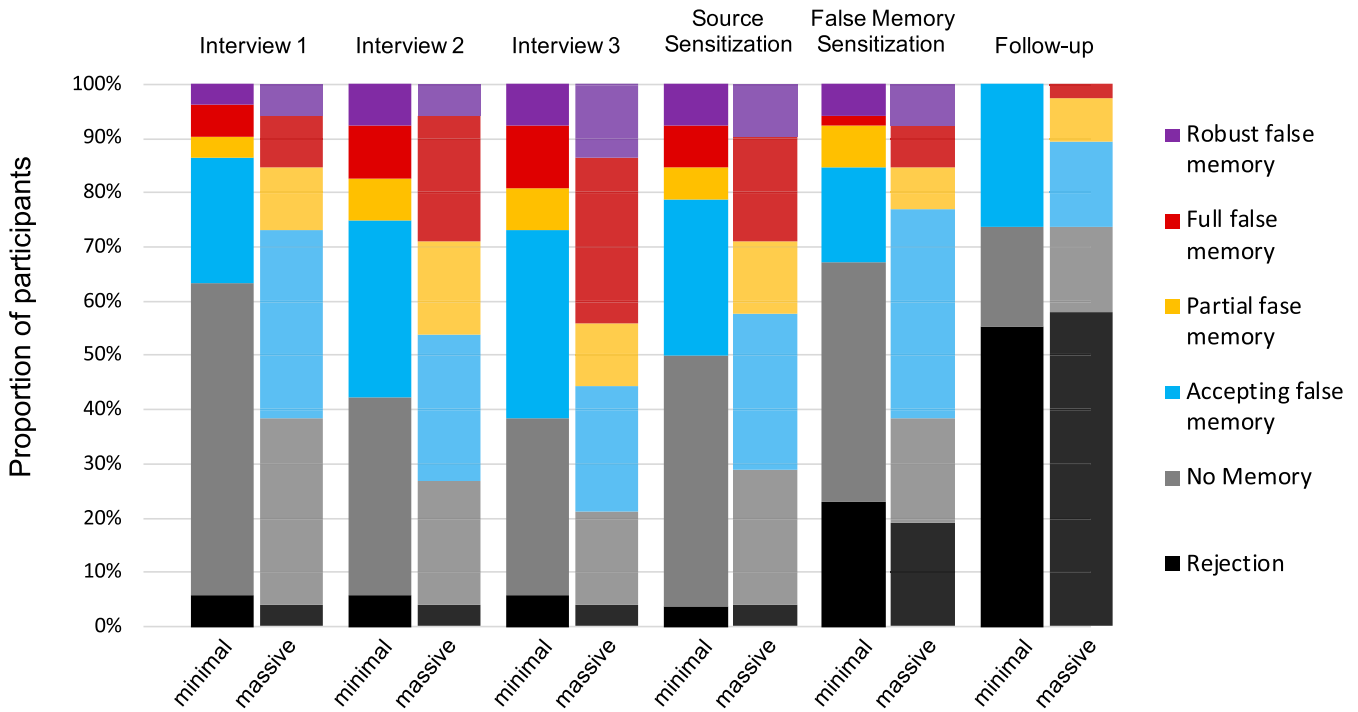

Fig. 2. False events only. Proportion of participants in each classification as a function of Measurement Occasion (1 through 3, after source sensitization, after false memory sensitization, follow-up) and suggestion (minimal, massive).

that the interview procedures at follow-up differed slightly from the original interviews (inevitably, see *Methods*), which is why we refrain from making direct statistical comparisons with the original study. Still, in absolute terms, there is very little endorsement of the false memories at follow-up. As shown further in Fig. 2, the overwhelming majority (74% across suggestion conditions) of participants either rejected the false event (mostly straight away—e.g., "Well this was one of the events that don't exist") or had no memory of it. The remaining events were mostly just accepted (i.e., merely believed to have happened), and in only a handful of cases ($n = 4$) in the massive suggestion condition one could still speak of false memories.

Statistical comparisons within the follow-up are still appropriate and show, unsurprisingly, a massive difference in memory quality between true and false events ($F(1, 37) = 126.02$, $P < 0.001$, $\eta_p^2 = 0.77$). More interesting, and different from what we expected, there was no statistical difference between the two suggestion conditions ($F(1, 37) = 0.21$, $P = 0.648$), unlike in the original interviews where massive suggestion resulted in clearly higher levels of false memory, even after source and false memory sensitization. That is, the effects of massive suggestion in the original interviews did not persist over time.

These findings were further validated by additional ratings (i.e., their self-reported belief in occurrence and recollection of events) participants provided in the follow-up. True events scored higher on both dimensions (belief: M = 6.34, SE = 0.17; recollection: M = 5.48, SE = 0.21) than false events (belief: M = 2.54, SE = 0.23; recollection: M = 2.77, SE = 0.19), with the differences being highly significant (belief: $F(1, 37) = 139.18$, $P < 0.001$, $\eta_p^2 = 0.79$; recollection: $F(1, 37) = 77.47$, $P < 0.001$, $\eta_p^2 = 0.68$). Furthermore, paralleling the coding-based findings above, there were no significant effects of the amount of suggestion (minimal versus massive; Fs < 2.4, Ps > 0.128).

Discussion

Our study demonstrates that successfully induced and consolidated (over three successive interviews) false memories can be substantially reversed again after the fact, using two ecologically realistic sensitization strategies that reshape the way interviewees approach the retrieval task (even before full debriefing). At a follow-up 1 y later, endorsement of the false memories further declined to a very low level of 5% overall. Several aspects of these findings are noteworthy and deserve further comment.

First, the incidence of false memory in our study, at least in the massive suggestion condition (56%), was relatively high compared to prior research [30% (29)], particularly in light of our blind interviewing procedure that minimized potential experimenter effects (67). We think this was partly due to our asking parents to come up with plausible events (22, 68, 69), making the suggestion more credible overall (25, 61, 69, 70) and avoiding implausible and probably ineffective suggestions (e.g., of a pet's death even though participants never had a pet). Supporting this idea, it is of interest that 44 participants (85%) indicated after debriefing that they thought they had simply forgotten about the false events. In turn, this provided them with an explanation for their lack of recollection, and they subsequently worked on "retrieving" (rather than reconstructing) them.

Second, while we eliminated most of the false memories at the end of the original interviews, some degree of acceptance of the false events persisted. In other words, our two sensitization strategies (source and false memory sensitization) mostly reversed false memories but not so much false beliefs. This probably reflects the residual credibility stemming from the combination of trustworthy university researchers and highly credible experts on the participants' childhoods (i.e., their parents) who were the sources of the false events. As a consequence, participants were unlikely to reject these events outright (71) and more likely to compromise somewhere between "no memory" and "accepting the occurrence of the

event," similar to the minimum suggestion condition in Interview 1, which served as a pragmatic baseline in our study (i.e., reflecting the participants' initial reaction to the mere probing of plausible parent-provided events).

Third, because this baseline already contained an element of suggestion [see also (72)] via experimenter and parent credibility (hence the name "minimal suggestion," not "no suggestion" condition), it may not be seen as a real-life baseline for the incidence of false memories—and, by implication, we may not have fully reverted the false memories back to a (possibly lower) real-life level. It is difficult to say, however, what the true base rate would be, not least because any probing of plausible past events (remember the parents were asked to provide events that were plausible for their child) might yield an above-zero rate of reporting. In any case, there is no doubt that we fully reversed all the incremental false memories obtained after the first interview and/or under massive suggestion conditions.

Fourth, the incidence of false memories and beliefs further changed at the follow-up where the majority of suggested false events were positively rejected, likely as a consequence of the full debrief at the end of the original interviews and ensuing conversations with parents to confirm the debrief. Interestingly, some degree of false memory rejection (~20%) was already present at the end of the original interviews, after false memory sensitization. It seems that being prompted to realistically consider the possibility of false memories helps disrupt a previous confirmatory mindset (i.e., trying to retrieve memories that "must be there").

Fifth, in line with much existing false memory research, the process of building up the false memories in our study was relatively simple, fast, and brief (i.e., 2 wk), and the process of reversal was even swifter (i.e., within minutes in the third interview session). By comparison, many real-world false memory cases involve much longer build-up times as well as additional techniques (47, 69, 73–77) and social pressure (78). It is difficult to say with any confidence how immediate and effective our reversal attempts would be under those circumstances; some existing research suggests that reversal of highly significant personal (false) memories can be less straightforward and take much longer (79). In any case, our study demonstrates that reversing false memories is possible in principle, offering a promising outlook for both future research and practice.

Sixth, with respect to practice, it cannot be emphasized enough that our two sensitization techniques were designed with ecological realism in mind—both source and false memory sensitization do not require ground truth knowledge [unlike many existing warning techniques (45)] and can therefore be implemented more widely. False memory sensitization was also designed to include a change of interviewer that occurs with regularity in real-life investigations, but it could also be administered by the same interviewer if necessary (e.g., if the investigation has brought new evidence to light that suggests the possibility of false memories). Furthermore, note that we administered the two techniques in a constant order (source sensitization first, then false memory sensitization), because false memory sensitization already implies some focus on sources other than one's own memory, and therefore this order seemed natural. It is an interesting question for future research if the entire package is needed to produce the effects or if the false memory sensitization alone may suffice.

Seventh, from an ethical perspective, and in light of previous research showing a resurgence of false memories after initial discrediting (78, 80), it is reassuring to see that this is not an inevitable outcome of false memory induction procedures. In fact, with our procedures, hardly any of the induced false memories survived at the 1-y follow-up.

Conclusions and Outlook

Finally, let us locate our findings more generally within the context of the ongoing false memory debate. Does our study support the idea that the case for false memories has been overstated (as some have argued, e.g., ref. 81) and that there is not much to worry about them as they can be made to go away? The answer is an emphatic no. What our study shows is that false memories can both be induced under suitable conditions and reversed under other suitable conditions. That is, in the most general sense, it demonstrates the dependence of false memories (or memories in general) on context. Pragmatically, this alerts us to the importance of interviewing conditions, or more generally memory retrieval context (e.g., our two suggestion conditions and the two sensitization strategies), and it also highlights the role of the social environment for scaffolding/upholding false or true memories (e.g., parents' statements were an important factor in the initial induction of the false memories and then most likely again in their abandonment after debriefing).*

In other words, our study reframes the discussion in terms of (false) remembering (statements about events that are codetermined by memory information and the context of remembering, e.g., ref. 61) rather than (false) memories (supposed stable entities within people's minds). This, again, is not meant to belittle the importance of false memories in any way (e.g., by suggesting that they are inherently transitory); quite to the contrary, social context will often help to sustain them (e.g., refs. 70, 79, 82–84), and there is no doubt whatsoever that false remembering/memories can have devastating real-life consequences. It does suggest, however, that—given the situational dependency of false remembering demonstrated here—focusing on the mere prevalence of false memories (as if it were a constant) in attempts to resolve the false memory debate leads to an unproductive dead end. Future research should rather seek (similar to the system factors approach in eyewitness identification research; e.g., refs. 85–87) to further our understanding of situational factors under the potential control of investigators that minimize the risk of producing/retrieving false memories and maximize veridical remembering.

Methods

Ethical Approval and Informed Consent. This research was conducted in accordance with American Psychological Association standards for ethical treatment of participants and was approved by the institutional review board of the Johannes Gutenberg University of Mainz (2017-JGU-psychEK-016). All parents and participants provided written informed consent before participating in this study; all participants agreed to the use of their data after full debriefing.

Participants and Design. As preregistered (https://aspredicted.org/me8at.pdf), we aimed at a sample size of $n = 56$ in order to be able to detect even small effects ($f = 0.1$). We recruited 91 participants altogether (no psychology students), but only 79 parents returned the questionnaires, of which 57 were filled out completely, which was a requirement for participation in the study. Fifty-six participants completed the study, but four participants had to be excluded after the interviews because the false events suggested by the parents turned out to be closely modeled after true events with only minor alterations and thus did not fully qualify as false events (as required by the preregistered inclusion criteria). Therefore, the final sample consisted of $n = 52$ participants (41 female, 11 male, $M_{Age} = 22.8$, $SD = 2.47$). Each participant was interviewed five times (suggestive interviews 1 through 3, plus source and false memory sensitization) about four events, resulting from the combination of event category (true, false) × suggestion condition (minimal

*Note that context also bears on the likelihood that false memories will be scrutinized and challenged in the first place. In many everyday situations, false memories are inconsequential enough and/or their sources are sufficiently trusted for us to never even contemplate the idea that our memory of something may be incorrect (see, e.g., ref. 70 for the role of social context in memory distortion). In this sense, even the best reversal techniques can only be effective if there is sufficient awareness of a potential for false memories in a given context.

suggestion, massive suggestion). Thus, the study comprised a 5 × 2 × 2 within-subjects design.

Parent Questionnaire. Following previous studies, we asked participants' parents to indicate in a list of negative events (20–22, 24, 26, 27, 88) whether these had happened to their children or not. Additionally, we asked them to generate two plausible negative events that had not happened (see https://osf.io/ser63/ for the entire parent questionnaire).

Interviews. To standardize interviews as much as possible, we used a modified version of the Step-Wise Interview (26) that has been used in prior research on false memories (27). All interviews began with a free recall phase (Step 1), followed by general open questions (e.g., "You mentioned x. Can you tell me more about it?") in order to clarify information provided during the free narrative phase (Step 2). Thereafter, more specific open questions about key details and phenomenological reports about sensory aspects of the incident followed (e.g., "Where exactly did it happen?", "Who was with you?", "Can you see/ hear/ smell/ feel/ taste things in your memory?", yes/no rating for each sense; Step 3).

There were no further interview parts in the minimal suggestion condition; in this condition, suggestive elements of the interview were limited to building rapport and informing participants that their parents had told us about the events. In the massive suggestion condition, additional suggestive influence was exerted through 1) encouraging further retrieval attempts when participants did not remember an event, 2) verbally reinforcing anything participants came up with, 3) using guided imagery and context reinstatement, 4) suggesting that recollection is mostly possible when trying hard enough, 5) claiming a detailed report provided by parents whenever participants expressed suspicions of parents' memories, and 6) asking participants to think about the events at home between interviews. The interview protocols for both suggestion conditions are available at https://osf.io/ser63/.

Each interview session started with the minimal suggestion condition and with the true event (in order to facilitate rapport and trust), followed by the false event. The massive suggestion condition was always realized for the third and fourth event, with the order of true or false events counterbalanced. Also, the order in which the four events were probed (and therefore also the assignment of events to conditions) stayed the same across all interviews. The source and false memory sensitization procedures that were aimed at reversing induced false memories took part directly after Interview 3, that is, in the third experimental session. Instructions in both interviews were provided orally but were highly standardized (see https://osf.io/ser63/).

Blinding of Interviewer and Coders. To minimize expectancy effects (89), the interviewer who conducted the three interviews and the source sensitization procedure was kept blind to the design of the study as well as the hypotheses being investigated. That is, although he was aware of the study being "somehow about false memories," he neither knew that every participant was being asked about two true and two false events nor was he familiar with the literature on false memories. The two coders (see below) were likewise kept uninformed about the topic of the study, its design, and the specific research questions and hypotheses being examined. Two additional measures contributed to their blindness: First, requiring them to rate not only false but also true memories, without informing them which were which, minimized any coding bias due to being aware of the truth status of a memory. Second, we adapted the coding scheme accordingly to accommodate both true and false events without giving the truth status away (e.g., coding "full memory" instead of "full false memory").

Materials and Coding. All materials (parent questionnaire, complete interview scripts, and the source and false memory sensitization instructions) were developed following previous studies but slightly extended and adapted (see above) and can be retrieved at https://osf.io/ser63/.

Memory reports were subsequently coded by two trained raters who were blind to the overall research question as well as the design of the study. The coding procedure was based on the classification developed by Scoboria and colleagues (29) but adapted in order to fit true events as well (see https://osf.io/ser63/ for the full coding scheme). Raters classified the quality of participants' recollections (1 = rejection of the event, 2 = no memory, 3 = accepting event, 4 = partial memory, 5 = full memory, 6 = robust memory). Importantly, "memories" were coded conservatively. That is, general information (i.e., not specific to the event in question), plausible assumptions (e.g., "if this happened in the Italy holiday, then it must have happened in the camping ground"), or speculations (e.g., "it could have been...") did not count as (true or false) recollections (see coding scheme for details). Initial interrater agreement was high ($r(1040) = 0.89$, $P < 0.001$), and disagreements were subsequently resolved by discussion. All analyses reported here are based on these agreed classifications. Given the high interrater agreement, the agreed codings were in turn highly correlated with the averaged initial codings ($r = 0.96$, $P < 0.001$), and therefore, parallel analyses based on averaged initial ratings (instead of agreed codings) led to an identical pattern of results (see https://osf.io/ser63/). Finally, the classifications resulting from our adapted coding scheme correlated highly with the classifications obtained with Scoboria and colleagues' procedure, ($r = 0.81$, $P < 0.001$), and again the same pattern of results emerged.

Follow-Up. A total of 38 participants (30 female, 8 male, $M_{Age} = 23.16$, SD = 2.44) took part in the follow-up interview about 1 y after the original study took place (M = 390.71 d; SD = 63.28). To minimize any expectation effects, the follow-up was conducted by yet another interviewer, who was blind to the experimental conditions. In addition, participants' event memory transcripts were coded by new raters ($r = 0.79$ prior to solving disagreements) who had not seen the previous transcripts.

Due to the participants having already been debriefed a year earlier, the interview procedure differed slightly from the original study. The interviewer first made it clear that she had joined this research project only at a later stage and then told participants that she wanted to find out what participants could still remember of the events they had previously been interviewed about. She emphasized that she was interested in both the content and quality of the memory, for instance, in the participant's confidence in it but also any reservations they might have about it or any thoughts they had when first reporting the event. We kept these instructions deliberately vague and neutral in an attempt to minimize demand characteristics.

Participants were then presented with the same brief summary of information regarding each event as in the original interviews and then completed Parts 1 and 2 of the Step-Wise Interview as described above (i.e., free recall and general open follow-up questions). Part 3 (questions about specific information and sensory details) was omitted because there was a risk that going through these details for events that participants might not remember any more or deny had happened (particularly after the debriefing) would feel very awkward and undermine their engagement with the study. However, in an effort to directly determine whether participants did or did not 1) hold a belief that the event had happened and 2) show genuine recollection of the event, the interviewer asked additional follow-up questions tailored to participants' reports (see https://osf.io/ser63/ for the verbatim interview protocol).

Subsequent to the interviews, follow-up participants were asked to fill out additional self-report measures separately for each event (https://osf.io/ser63/). These included three Belief in Occurrence and three Recollection items taken from previous research (90) as well as the Memory Characteristics Questionnaire (91, 92). For the sake of brevity, results based on the Memory Characteristics Questionnaire are not reported here, but the effects were the same as those based on coding of memory reports and on the Belief in Occurrence and Recollection items.

Statistical Analyses. All statistical tests reported in this manuscript were two-tailed and guided by our preregistered hypotheses (https://aspredicted.org/me8at.pdf; https://aspredicted.org/bw9x8.pdf; https://aspredicted.org/9ws66.pdf). Our main findings are based on repeated-measures ANOVA across the above-specified interviews and with suggestion condition (minimal, massive) and event type (false, true) as within-subjects factors as appropriate. Violations of the sphericity assumption were met with the Greenhouse–Geisser correction. Pairwise comparisons were performed using Student's t tests. To check the robustness of our findings, we additionally performed nonparametric analyses; these produced an identical pattern of results (https://osf.io/ser63/).

Data Availability. Anonymized (.sav) data have been deposited in Open Science Framework (http://dx.doi.org/10.17605/OSF.IO/SER63) (93).

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