Are Misinformation Effects of Questions with False Implications modulated by At-Issueness?

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Abstract

We present the results of an experiment investigating the comprehension of questions about previously shown pictures with geometrical objects and resulting intrusion errors on representations in memory. We manipulated whether definite and indefinite descriptions were at-issue or non-at-issue to the task at hand. For this purpose, descriptions were embedded into restrictive vs. non-restrictive appositive relative clauses. The responses to the questions provided evidence for participants' awareness of presupposition violations. Moreover, false presuppositions had an effect on an immediately following memory task. This effect was present no matter whether the presupposition trigger appeared in an at-issue or non-at-issue context. Furthermore, question processing as well as visual memory was unaffected by the wording of the misinformation: in the constructions under investigation, indefinite descriptions patterned with definite descriptions.

Keywords: misinterpretation effect; intrusion errors; constructive memory; presupposition processing; (non-)at-issueness

Introduction

When we encounter new information, this information is immediately integrated into our memory and can thus cause alterations and supplementation of our memory of prior events (Loftus, 2019; Loftus & Klemfuss, 2024). If this new information is false, it can lead to memory errors and give rise to what has been called the *misinformation effect*. This effect, which takes the form of intrusion errors, has been demonstrated in seminal studies by Loftus (1975) and Loftus et al. (1978). During the last decades, misinformation effects have been shown in a variety of tasks and a number of explanations have been put forward and critically evaluated (see Fiedler, Walther, et al., 1996; Loftus, 1979; Loftus & Klemfuss, 2024; Pantazi et al., 2018; Walter & Tukachinsky, 2020; Wiechert et al., 2026, for discussion and reviews). The present study investigates the misinformation effect again, but addresses it from a psycholinguistic perspective bringing together memory effects with processing effects during the linguistic interpretation of new and, in the critical trials, misleading information. More specifically, we compare classic effects of the "wording" of the new information (Loftus & Zanni, 1975) – that is, whether it appears in the form of a definite or an indefinite description – and contrast wording with whether it is at-issue for the task at hand or non-at-issue (Koev, 2018). If not at issue, we put forward the hypothesis that false information may be overwritten more easily and thus constructively added to memory than when it interferes with the task and therefore has to be explicitly rejected or defeated (Fintel, 2004). The present paper thus (again) takes up the question how pragmatic context influences the misinformation effect (Dodd & Bradshaw, 1980, a.o.) and what cognitive mechanisms are responsible for this effect (Zang et al., 2023, a.o.).

Presuppositions: Triggers and At-Issueness

The question of whether and how false implications modulate visual memory has been experimentally addressed in a wide variety of linguistic contexts. To give just a few examples, Loftus et al. (1978) employed questions with false definite descriptions such as (1-a) while Fiedler, Armbruster, et al. (1996) employed questions such as (1-b).

(1) a. Did another car pass the red Datsun while it was stopped at **the stop sign**?
b. Was **the umbrella stand** in the hallway made of brass?

An important thing to note is that these definite descriptions appear in very different environments, that is within a temporal adverbial clause or a configuration with a complex noun phrase structure itself embedding another definite description. Some of these environments, temporal adverbial clauses, for instance, can themselves act as presuppositions depending on their context of use (Beaver et al., 2024; Frege, 1892; Levinson, 1983). As a consequence, exchanging *the stop sign* by the indefinite description *a stop sign* does not change the backgrounded nature of this information, it is still given and projects as revealed by inference patterns, e.g., under negation in the family-of-sentences tests (Chierchia & McConnell-Ginet, 2000; Tonhauser, 2015; Tonhauser et al., 2013). A second important pragmatic factor, often not explicitly considered in the memory literature, is the relevance of the false information. By relevance, we mean whether the information is required for addressing the question. Considering (1-a) in the context of the course of events of Loftus et al. (1978), it may not be of any importance whether the car stopped at a stop or at a yield sign. Based on the literature on presupposition accommodation this should interfere with how easy it is to modulate the context representation in memory, a process probably related to accommodation.[1] If a presupposition is to

[1]The two processes have to be clearly set apart, though, because accommodation consists in the addition of content to the common

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be interpreted by way of accommodation, new information is presented as if it were in the common ground, and it has often been observed that this will only work if the information is not contentious or otherwise remarkable (Beaver et al., 2024; Lewis, 1979; Simons, 2006). This plausibly should much more be the case for content that is non-at-issue than content that is relevant for the identification of the referent (Koev, 2018) as, for instance, evidenced by the demonstrated higher degree of pervasiveness of presupposed contents (Thoma et al., 2023) and their difficult identification by Large Language Models (Sieker et al., 2025). In the present study, we therefore orthogonally manipulated two things: A) the at-issueness of the misleading information in the question, and B) the wording by presenting the misleading information either in a definite or an indefinite description. This put us in the position to distinguish effects of mere wording from pragmatic effects related to communicative purposes. Our working hypothesis was that the mere wording should not have an effect, but that at-issueness and relevance should be the driving forces underlying modifications of memory representations. Thus, in cases in which the misleading information appears in a non-at-issue environment it should lead to a higher degree of intrusion errors than if it is at issue (**Hypothesis 1**). A more extreme hypothesis may consist in the conclusions by Fiedler, Armbruster, et al. (1996) that no matter of their exact discourse pragmatic properties, all types of propositional content can affect memory representations.

Another desiderata not fully addressed in the existing literature is the exact interaction of the processing of the question with the context information held in visual memory. We therefore set up a task that allows to study the processing of the question in terms of reading behaviour as well as question answering. Moreover, the question-answering task was set up in such a way that comprehenders could reject the question as *odd* in case they were unwilling to provide a positive or negative answer (see Bott et al., 2025, for an application). Thus, the false information does not have to be endorsed as this was usually the case in the classic studies. This is because in case of a leading question both *yes* and *no* give rise to the presupposition inference. Note, that a *don't know* option does not help in this respect, either, because the participants are expected to exactly know the state of affairs.

Our research builds on a rich body of experimental work on presupposition processing in psycholinguistics (see, e.g., Schwarz, 2019). Presupposition violation has been repeatedly shown to immediately delay reading times (Tiemann et al., 2011, i.a.) and lead to *odd question* responses in question-answering tasks with this response option (Bott et al., 2025). Moreover, accommodation is a costly process affecting the online interpretation of to-be-accommodated content (Domaneschi & Di Paola, 2017). In case the presupposed information can be accommodated, comprehenders respond positively to questions querying the presupposed content. We thus derived the following processing prediction for the update with false information in questions with misleading information (**Hypothesis 2**): In the case of processing a question with false information in a non-at-issue environment, a delay in question processing due to an update with this information will be observed during reading and responses to these questions should be indicative of a positive update with this information. If the information is at-issue, however, a violation effect is expected during reading and negative or odd-question responses are expected depending on the pragmatic status of the information.

Hypotheses 1 and 2 were investigated in a task that allowed to relate question processing and answering to performance in the memory task. In addition, the experiments employed a more artificial and minimal setup than previously done in research aimed at informing research on the reliability of eyewitness reports (Mickes et al., 2025; Yuille & Cutshall, 1986). In the present study, by contrast, we will always only be concerned with simple visual scenes containing a handful of geometric objects about which a single question is asked which is then immediately followed by a memory check. The aim is to get a snapshot of the update processes, respectively.

Methods

The study was conducted as an internet experiment. It was preregistered (link to preregistration) and all experimental materials and analysis scripts can be found in an accompanying OSF archive (link to OSF repository).

Participants

81 participants (9 per list) were recruited from Prolific (prolific.com) applying the following screeners: German as a native language and language of schooling, no issues seeing colors and participation only via a desktop PC. Based on performance on the fillers (at least 66% correct in the question-answer task as well as at least 70% correct in the memory task and reliable timing accuracy measured on invariable parts of the trial, cf. Mathôt and March (2022)), 37 participants were excluded, leaving 44 participants in the analysis: 11 female, 33 male, 0 of other genders with a mean age of 29.8 years (range 18-52). Each participant received 5 GBP.

Materials

45 items were constructed in nine conditions each according to a 3 (QUESTION TYPE) × 3 (PICTURE CONTEXT) factorial design. Each item was realized in three question conditions. The first QUESTION TYPE embedded a relative clause (RC) hosting a definite description (2). In the second type, instead of a definite an indefinite noun phrase was used (3). Thirdly, a control condition was constructed with RCs not imposing any restriction (4) but being superficially similar in length and structure. These RCs made reference to the entire picture. The items varied with respect to the relations used (*above*, *below*, or *besides*) as well as the colors (six colors in total)

ground (Karttunen, 1974; Lewis, 1979; Stalnaker, 1974), whereas memory intrusion has often been described in terms of constructive memory processes overwriting the existing memory representation (Fiedler, Armbruster, et al., 1996; Loftus, 1979).

and shapes (squares, circles, triangles, stars and rectangles) of the objects referred to in the matrix clause and the RC.

(2) Ist das Quadrat, das über dem blauen Dreieck ist, rot?
(is the square above the blue triangle red?)

(3) Ist das Quadrat, das über einem blauen Dreieck ist, rot?
(is the square above a blue triangle red?)

(4) Ist das Quadrat, das auf dem eben gezeigten Bild ist, rot?
(is the square on the just-shown picture red?)

The questions were paired with three PICTURE CONTEXT conditions as illustrated in Table 1. Pictures always contained four or five objects in total. The picture contexts manipulated the at-issueness of the RCs by making them appositive (only one target object present, e.g. a square) or restrictive (two target objects present). Note that in German, both appositive and restrictive RCs are separated by commas from the main clause making them indistinguishable in the surface form. In the two critical PICTURE CONTEXT conditions, the object mentioned in the RC, was not present in the picture. The difference between the appositive and the restrictive RCs is that in the latter, but not in the former, a uniqueness presupposition violation occurs with respect to the RC-embedding definite noun phrase ('the' square). In addition to these critical conditions, a baseline PICTURE CONTEXT condition was added, in which the (here also appositive) RC made reference to an object previously shown in the picture.

Each picture context was paired with a competitor picture which was manipulated in such a way that it matched the content of the RCs. The same pictures (with target and competitor pictures exchanged) could be used in the baseline and the non-restrictive conditions. These pictures were minimally manipulated to create the pictures for the restrictive context set. Thus, in total each item included 4 picture contexts (2 target and 2 competitor pictures). The 45 items in the nine conditions were distributed to nine lists in a Latin square design.

Table 1: Sample materials (target vs. competitor picture).

	baseline	appositive	restrictive
target			
comp.			

In addition, 30 question-picture pairs (+ competitors) were added as distractor trials. These fillers were of three types. False fillers (N=19) did not involve any presupposition violation but required a *no* answer. Note that the experimental items always involved presupposition violations or required *yes* answers making it necessary to add a substantial number of '*no* fillers'. In addition, we also constructed fillers that required a *yes* answer (N=7) and fillers displaying presupposition violations (N=5). The latter were simple questions with violations of existence presuppositions such as *is the circle purple?* in the absence of any circles. We used these fillers to screen for participants that provided *no*, *yes* and *odd question* responses, respectively. These fillers were added to each of the nine lists.

Finally, six practice trials were constructed: two required *yes* responses, two called for *no* responses and two embodied *odd question* responses. All experimental materials can be found on the OSF repository accompanying this paper.

Procedure

The experiment was conducted as an internet experiment via Prolific and was implemented in OpenSesame (Mathôt et al., 2011) with the OSWeb interface (Mathôt & March, 2022). The experiments were run on a Jatos server (Lange et al., 2015) hosted at Bielefeld University.

An experimental session started with participants being directed to our server and the browser window switching to full screen mode. They were asked for informed consent and then were queried for demographic data. Afterwards, they proceeded to written instructions in which the task and the trial structure were explained. Moreover, oddness of questions was briefly discussed in the context of an example with a presupposition violation (using a particularly clear case, i.e. *are more than three of the squares red?* in the absence of any squares, cf. Bott et al., 2025). This was followed by a practice session on which each trial was followed by acoustic feedback for the memory task (applause vs. wrong answer gaming sounds) but not for the question task.

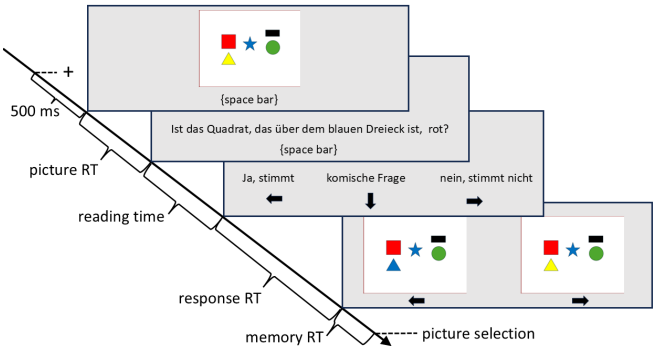

Figure 1: Trial sequence in the experiment (here: appositive RC & definite condition). Transl.: *is the square, that's above the blue triangle, red?*; answers: *yes, true* (left arrow key), *odd question* (down arrow key), and *no, false* (right arrow key). Response keys are depicted for illustration purposes.

The trial structure is illustrated in Figure 1. Every trial started with a *ready for the next trial* screen. After pressing space bar, a fixation cross appeared in the center of the screen for a duration of 500 ms. before automatically displaying the picture. There was no time limit and the participants proceeded to the question screen by pressing space bar. After having read the question they paced themselves to the answer screen by pressing space bar again. On the answer screen, the three responses (*yes*, *odd question* or *no*) were shown together with the response keys (left, down, right arrow key), respectively. By pressing one of these keys, the memory task was displayed on a screen showing the original and the competitor picture on the left- and the right-hand side of the screen (counterbalanced for target position) and participants had to select one of these pictures by pressing the left or the right arrow key, respectively.

The order of trials was individually randomized for each participant. The experiment was presented in a single block. A typical experimental session had a median time of 29 minutes on task.

Data (Pre-)Processing and Statistical Analysis

After exporting result files from JATOS and merging the data from all lists into a single spreadsheet, all analyses were carried out in R (v.4.5.1 R Core Team, 2025) applying the tidyverse (v.2.0.0 Wickham et al., 2019) and lme4 packages (v.1.1-37 Bates et al., 2015).

First, participants were screened and excluded if their performance on the fillers (N=36) or timing accuracy (N=1) was insufficient. For the remaining 44 participants, all RT data were cleaned by eliminating outliers. All RTs below 250 ms. or more than 2.5 SDs above a participant's mean RT were removed from the data as well as RTs exceeding absolute thresholds (10 sec. for reading, 4 sec. for responding and 7.5 sec. for the memory task).

We analyzed reading times of the questions, the responses and response latencies, as well as intrusion errors and memory task RTs as a function of PICTURE CONTEXT and QUESTION CONDITION. For inferential statistics, all latencies were analyzed in linear mixed-effects regression analyses including random intercepts of participants and items.[2] All models included the fixed effects of PICTURE CONTEXT and QUESTION CONDITION as well as their interactions. The two contrasts of PICTURE CONTEXT were sum-coded with the baseline conditions serving as reference level (contrast 1: baseline vs. non-restrictive; contrast 2: baseline vs. restrictive). QUESTION CONDITION was Helmert-coded with a first contrast comparing the control condition with the two conditions involving definite and indefinite noun phrases and a second contrast comparing definite and indefinite descriptions relative to each other. Responses and memory choices were analyzed in logit mixed-effects regression analyses using the same random-effects and fixed effects. For the answers to questions we modeled the log-odds of *yes* answers vs. all other answers, which corresponds to the likelihood of accommodation in the critical conditions with unjustified contents. For the memory task, we modeled the log-odds of making an intrusion error.

Results and Discussion

In the following, we will first present the analysis of question answering, followed by the analysis of reading times for the questions. Finally, the findings of the memory task will be discussed.

Question Answering

The question-answering task with the three response options developed by Bott et al. (2025) set the conditions clearly apart from each other (see Figure 2). The baseline conditions as well as the non-restrictive control condition, for which the expected answer was *yes*, received *yes* answers about 75% of the time. The relatively large number of errors in these conditions shows that the memory for the target pictures was far from perfect.[3] Interestingly, participants did not accommodate in the non-restrictive conditions with definite or indefinite descriptions but rejected the questions as *odd* (41%) or responded *no* (35%). A similar pattern was observed in the restrictive RC contexts with only 17% *yes* responses in the definite and indefinite conditions but a substantially higher rate of accommodation (54% *yes*) in the control condition. Thus, they tended to provide a *yes* response even though there was another target object for which the answer would have been *no*. Thus, a large number of participants seemed to make the question fit the context, for instance, by switching to an interpretation with an indefinite instead of the definite description (*were there any red squares?*). However, also a large proportion of *odd question* responses was observed (33%).

This pattern was reflected by two significant interaction effects in the GLMER analysis. As for the comparison between non-restrictive and baseline contexts, the interaction between PICTURE CONDITION (contr. 1) and QUESTION CONDITION (contr. 1: control vs. def./indef.) was significant ($\chi^2(2) = 43.192, p < .001$). This interaction was due to the fact that in the non-restrictive picture contexts both questions with definite and indefinite descriptions were answered less often with "yes" as the baseline conditions but also the control condition. Turning to restrictive relative clauses, all questions with definite and indefinite descriptions were answered less often with *yes* than the baseline conditions but also the control condition leading to a significant PICTURE CONDITION (contr. 2) × QUESTION CONDITION (contr. 1: control vs. def./indef.) interaction ($\chi^2(2) = 25.695, p < .001$).

Interestingly, there were no effects of wording, as revealed by the lack of any effects involving the second contrast

[2] This was the maximal random-effects structure for which regression models converged. See the RMD script plus data and plots at OSF including detailed information on random effects structures.

[3] In fact, the task was relatively hard as revealed by the large number of participants (19 out of 81) that had to be excluded because of a success rate on the fillers of less than 66%. Exclusion criteria had even to be somewhat relaxed relative to the original criteria as specified in the preregistration.

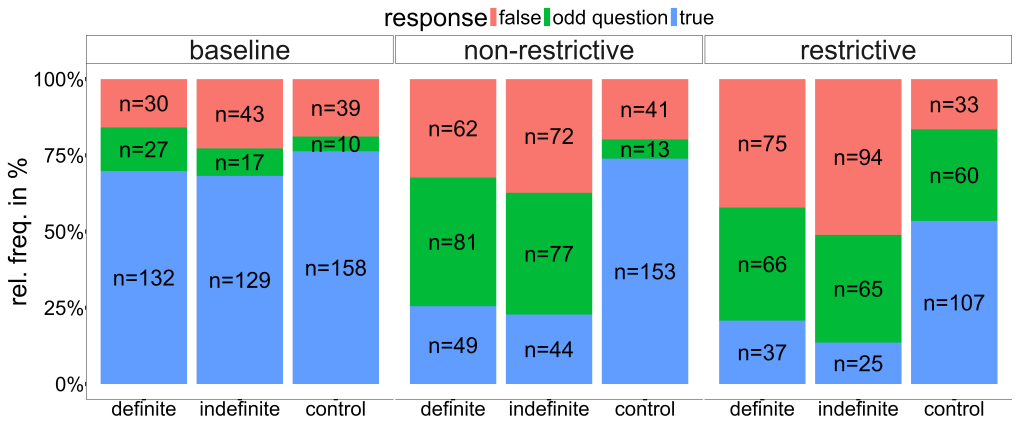

Figure 2: Distribution of answers in the question answering task. In the baseline and the non-restrictive control condition, *yes* answers were the expected answers. In the other conditions, presupposition violations could result in *odd question* (or, in the case of logical replies, *false*) answers. Accommodation should result in a *yes* response.

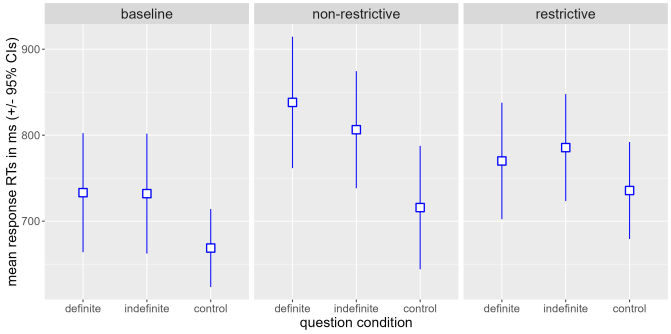

Figure 3: Mean response RTs and 95% confidence intervals.

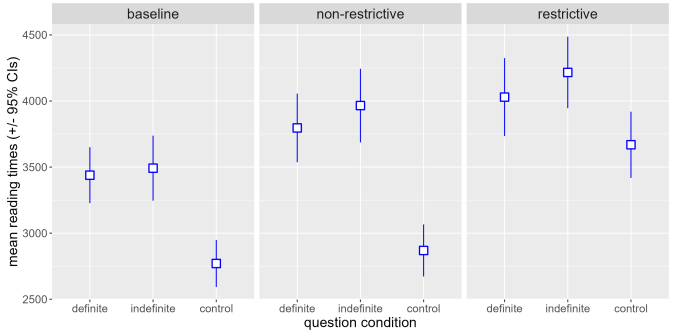

Figure 4: Mean reading times and 95% confidence intervals.

of QUESTION TYPE, i.e. definite vs. indefinites ($\chi^2(3) = 4.015, p = 0.260$). While the at-issue manipulation had a clear effect, it was thus of no relevance whether a definite or indefinite article was used in the description.

The response times are shown in Figure 3. Overall, two main effects in the absence of interactions were found. Firstly, answer RTs for control questions were across all picture contexts faster than answer RTs of questions with definite or indefinite descriptions ($\chi^2(2) = 12.711, p < 0.01$). Secondly, questions in the non-restrictive conditions took generally longer to answer than questions in the baseline condition ($\chi^2(1) = 9.657, p < 0.01$). This significant contrast indicates that participants may have been more unsure in the non-restrictive conditions due to interference between the RC in the question and the picture context than in the other two types of contexts.

Question Reading Times

The reading times of the questions are shown in Figure 4. The reading times are fully in line with the above sketched processing predictions for presupposition binding and presupposition violation. We observed the smallest reading times in the baseline conditions and here in particular in the control condition. The latter was at the same level in the non-restrictive control condition. However, the appositive RCs with a definite or indefinite description led to substantially longer reading times than their baseline counterparts. For the restrictive RCs with all three conditions displaying presupposition violations, reading times were always longer than in the baseline conditions, respectively.

In the LMER analysis we accordingly found an interaction effect in the comparison between non-restrictive and the baseline conditions regarding the processing of the control conditions vs. the definite and indefinite descriptions ($\chi^2(2) = 6.799, p < 0.05$). Follow-up analyses revealed that the control conditions did not differ across contexts but definite/indefinite conditions gave rise to a reliable context effect. The contrast comparing restrictive vs. baseline contexts gave rise to a main effect of PICTURE CONTEXT ($\chi^2(1) = 93.147, p < .001$). Thus, questions with restrictive relative clauses took longer to read than the questions in the baseline context.

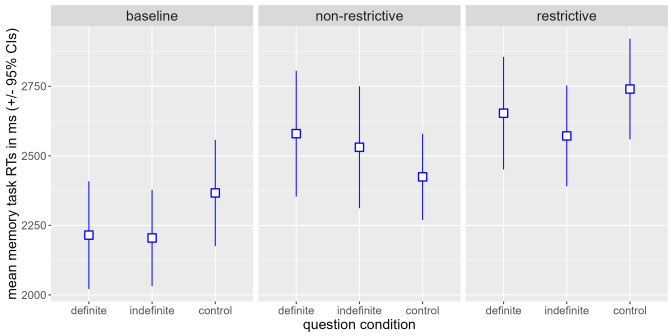

Figure 5: Mean memory task RTs (and 95% CIs).

Consistently with what has already been reported above for question answering, there were no effects of wording (no sign. effects involving the second contrast, definite vs. indefinite NP, of question type: $\chi^2(3) = 1.987, p = 0.575$). Thus, it did not matter whether the critical target object was referred to by a definite or indefinite description, but rather its at-issueness status and relatedly whether it matched or violated the depicted state of affairs.

Memory Task

The mean error rates in the memory task are reported in Table 2 and the RTs are shown in Figure 5. The performance in the memory task was good with a mean of 86.8% correct.

In the non-restrictive context conditions with their mismatch between the linguistic information in the questions and the visual information in the picture context, about twice as many errors occurred in the question conditions with definite and indefinite descriptions (baseline def./indef.: 8.2% errors; non-restrictive def./indef.: 16.4% errors). The logit mixed-effects regression analysis provided evidence for an intrusion effect in these conditions (interaction PICTURE-contrast-1 × QUESTION-contrast-1: $\chi^2(2) = 15.825, p < .001$). Breaking down this interaction in two subset analyses for the baseline and non-restrictive conditions separately from each other, showed significantly higher error rates for definite and indefinite descriptions relative to the control condition in the non-restrictive conditions ($\chi^2(2) = 9.062, p < .05$) but no reliable difference in the baseline conditions ($\chi^2(2) = 4.524, p = 0.104$).

In the restrictive RC conditions, intrusion effects could be observed, too. Here mismatching information led to a main effect ($\chi^2(1) = 4.032, p < 0.05$) in the absence of an interaction ($\chi^2(2) = 3.7333, p = 0.155$). The observed 4.8% difference between the baseline (9.1% errors) and the restrictive conditions (13.9% errors) thus turned out to be reliable.

In summary, both contexts with mismatching information gave rise to reliable intrusion effects, which were, however, somewhat smaller in absolute size compared to some of the previous studies on intrusion effects (Fiedler, Walther, et al., 1996; Loftus et al., 1978), but well in the range of others (Dodd & Bradshaw, 1980; Loftus & Zanni, 1975). For instance, Loftus and Zanni (1975, Exp. 1) found a similarly sized contrast between 7% intrusion errors for their indefinite baseline and 15% errors in the definite conditions.

Table 2: Error rates (in %) in the picture-selection task on the visual memory for the stimuli (N=220 trials per condition).

Question Type	Baseline	Non-Restrictive	Restrictive
Definite	10.6	15.6	17.4
Indefinite	5.8	17.1	11.4
Control	10.6	8.2	13.0

Conclusions and Open Questions

The present study investigated the processing of questions with false information and the resulting effects on the memory for visual scenes. The findings provide evidence against both main hypotheses (Hypotheses 1 and 2, above). Firstly, drawing participants' attention to questions by having to consider their overall sensibility, led them to reject or negatively respond to all questions with false information, no matter whether the mismatch affected the at-issue or the non-at-issue content. We did thus not observe any implicit updates of the memory representation that would allow for the endorsement of these questions. Likewise, we did not find intrusion errors to occur more frequently in the non-at-issue conditions. Instead, they occurred with equal frequency for both types of misinformation. This is consistent with Fiedler, Walther, et al. (1996), who proposed that memory intrusion errors can be triggered by any propositional content irrespective of its semantic or pragmatic properties.

The processing data on questions containing misinformation are interesting in their own respect. The experiment clearly demonstrated that the violation of semantic (in the restrictive RCs) and pragmatic constraints (in the appositive RCs) have clear processing implications. However, the wording of the misinformation, whether realized as a definite or an indefinite description, did not have any effect. This helps to further sharpen claims made in previous research (Loftus & Zanni, 1975).

A lot of open questions remain for future research. The present study implemented the 'minimal setup' of a combined question-answering and memory task with only a single target question, which immediately followed the picture context. In future research we plan to add more questions to the question stage and see how this will affect both question processing and visual memory. We suspect that implicit memory updates in the face of (especially non-at-issue) misinformation will more likely occur once the target question is embedded into a sequence of questions on a given picture context. In addition, the particular position in such a sequence and the nature of surrounding questions is likely to influence reactions to leading questions and their effects on memory – reminiscent of well-established findings from research on eyewitnesses' memories (Loftus, 2019).

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