



“Questioning” the truth effect: Processing information in interrogative form reduces (but does not cancel) repetition-induced truth

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Abstract

People attribute higher truth to information they have previously been exposed to. This “truth effect” is resistant to many interventions aimed to reduce it. In three preregistered experiments, we explored whether processing largely unknown information in the form of questions could counteract repetition-induced truth. In Experiment 1 ($N = 100$), participants judged the truth of repeated and unrepeated sentences. Half of the participants processed sentences in declarative form and the other half processed them in interrogative form during exposure and judgment. A significant interaction between sentence repetition and sentence form emerged, with a significant truth effect in the declarative condition but not in the interrogative. Experiment 2 ($N = 325$) introduced an additional interrogative condition presenting sentences as questions only during the exposure phase. Compared with the declarative condition, the truth effect was greatly reduced, but still significant, in both interrogative conditions. Experiment 3 ($N = 235$) employed a within-participant design to manipulate both repetition and sentence form. We confirmed that the truth effect was substantially reduced for interrogative sentences. Additionally, repetition had a smaller effect on certainty about truth judgments for interrogative compared with declarative sentences. We discuss how these findings inform theoretical accounts of the truth effect and their implications for debiasing strategies.

Keywords Truth effect · Illusory truth effect · Repetition · Fluency · Questions

Introduction

It was Napoleon, I believe, who said that there is only one figure in rhetoric of serious importance, namely, repetition. The thing affirmed comes by repetition to fix itself in the mind in such a way that it is accepted in the end as a demonstrated truth.

Gustave Le Bon (1895/1996, Chapter 3.2)

In succinct terms, Gustave Le Bon captured the profound impact of repetition on perceived truth, a phenomenon that still receives enormous attention in psychological science. Yet, Le Bon’s proposition conceals a potential boundary of the phenomenon. In his words, repetition exerts its influence on truth for things that are *affirmed*. What, then, would

happen for things not affirmed? This paper explores this question by testing whether information that is not affirmed, but *questioned*, is vulnerable to repetition-induced truth.

When asked to determine whether a statement is true or false, people are influenced by prior exposure. People believe repeated information to a greater extent than new information. This phenomenon is known as “illusory truth effect,” “truth-by-repetition effect,” or “truth effect” (see Unkelbach et al., 2019). Initially introduced by Hasher et al. (1977), this effect is typically demonstrated via a paradigm where participants are first exposed to a series of statements (exposure phase); next, those same (repeated) statements plus other (new) statements are presented to be judged for truth (judgment phase). The truth effect is reflected by a higher truth attributed to repeated, as opposed to new, statements.

The truth effect is a robust and pervasive phenomenon (for a meta-analysis, see Dechêne et al., 2010). Repetition increases the perceived truth of consumer advertising (Johar & Roggeveen, 2007), social-political opinions (Arkes et al., 1989), rumors (DiFonzo et al., 2016), health claims (Unkelbach & Speckmann, 2021), and stereotypes (Mattavelli et al., 2024b; Oğuz Taşbaş & Unkelbach, 2022). Whereas

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people tend to underestimate the impact of repetition on their truth judgments (Mattavelli et al., 2024a) evidence of a truth effect has been found even for statements that contradict one's prior knowledge (Fazio, 2020; Fazio et al., 2015, 2019; Lacassagne et al., 2022); when participants are told that information is false (Begg et al., 1992; Skurnik et al., 2005; Unkelbach & Stahl, 2009; see also Henkel & Mattson, 2011); in the face of advice from reliable sources (Unkelbach & Greifeneder, 2018); and despite monetary incentives (Speckmann & Unkelbach, 2021). Pennycook et al. (2018) proposed that repetition might be one factor that increases the tendency to believe fake news (see also Pillai & Fazio, 2021; Udry & Barber, 2023). In an era where information is abundant and easily disseminated through various channels, the susceptibility to the truth effect takes on a heightened significance.

Contrasting the truth effect is, however, possible (Brashier et al., 2020; Calio et al., 2020; Nadarevic & Abfal, 2017; Nadarevic & Erdfelder, 2014). One effective strategy involves warnings, with participants informed about the truth effect and encouraged to resist it. Studies by Nadarevic and Abfal (2017) found modest evidence of a reduced but still significant truth effect in the “warnings” condition, compared with a control condition (see also Calio et al., 2020, Study 2). Another strategy relies on accuracy focus (Brashier et al., 2020). Using falsehoods, Brashier et al. (2020) prompted participants to behave as fact-checkers by asking them to focus on information accuracy. Fact-checking falsehoods eliminated the truth effect, but only with statements concerning which participants possessed prior knowledge. In the absence of knowledge, a truth effect in the accuracy focus condition persisted and was comparable with that observed in the control condition.

Relatedly, and of relevance for the present research, Calvillo and Harris (2023) tested the effect of presenting headlines as questions, a practice that is often used by fact-checking websites. In two studies, they exposed participants to declarative and interrogative headlines regarding which participants held prior knowledge—that is, participants knew whether information was factually true or false. Next, they asked participants to rate those old headlines plus some new ones (all judged in their declarative form) for truth. A truth effect was found for headlines priorly stated, but not for those priorly presented as questions. The authors interpreted the observed effect in light of questions increasing an accuracy focus. Because (a) questions might trigger a more analytical, accuracy-focused process and (b) individuals possessed prior knowledge about the truthfulness of the information, they were more likely to be accurate (i.e., they rated repeated information based on information truthfulness) when information was presented in the interrogative form. However, this explanation may not generalize to situations in which people lack prior knowledge, that is, when

individuals are exposed to complex information. In such cases, where knowledge about factual truthfulness is relatively low, questions may operate differently. By focusing on largely unknown information, our research provides an opportunity to test whether the effect of interrogative framing observed by Calvillo and Harris (2023) persists under conditions of reduced knowledge. This would ultimately open to new, alternative explanations for the ability of questions to weaken repetition-based increases in perceived truth.

Exploring the impact of sentence form on the truth effect has important theoretical implications. Several explanations have been proposed for this phenomenon. Bacon (1979) argued that recognizing repeated statements (i.e., judging them as “repeated”) is the critical process (see also Mattavelli et al., 2023). A related explanation is familiarity: Arkes et al. (1989) suggested that repeated statements feel more familiar, leading people to judge them as more likely to be true. Closely tied to this, processing fluency (i.e., the subjective ease of mental processing; Clore, 1992) has also been implicated in the truth effect, as fluent statements tend to be perceived as more truthful. More recently, Unkelbach and Rom (2017) proposed a referential network account, arguing that repetition strengthens associations between statements and their referents in memory, leading to increased truth judgments. Importantly, these mechanisms are not mutually exclusive; rather, they may operate in tandem or reflect different aspects of the same underlying cognitive process. For example, familiarity may result from recognition, and increased fluency may arise from both. Similarly, the strengthening of referential networks through repetition could facilitate both recognition and fluency. While these theories propose different cognitive mechanisms responsible for the truth effect (i.e., recognition, familiarity, fluency, and referential networks), they all share the assumption that repetition enhances perceived truth.

However, an ecological account of the truth effect (Unkelbach & Greifeneder, 2013) challenges the notion that repetition and truth are inherently positively linked. Instead, this account suggests that the relationship between repetition and truth is context-dependent, shaped by the ecology in which judgments occur. For example, in most real-world situations, true information is repeated more often than false information, reinforcing the intuitive link between repetition and truth (Reber & Unkelbach, 2010). However, when the context shifts, so does the effect of repetition on truth judgments. For instance, Corneille et al. (2020) found that in the context of fake news, repeated information was perceived as more fake than novel information, possibly because repetition signals deception in that ecology. We propose that modifying the syntactic structure of information (i.e., from declarative statements to questions) may create an “ecology of questions,” wherein the typical link between repetition and truth is weakened. Whereas in the ecology of

statements, what is true occurs more often (i.e., it is more repeated), in the ecology of questions, this link is less valid. Following this reasoning, our research primarily builds on the ecological account of the truth effect, examining whether an “ecology of questions” might weaken the typical link between repetition and truth. At the same time, investigating the impact of questions may also provide insight into the cognitive mechanisms underlying the truth effect, such as recognition, familiarity, fluency, and referential networks.

The present research

Across three experiments, this paper investigates the impact of framing information as statements (i.e., declarative condition) or questions (i.e., interrogative condition) on the truth effect. Sentences were selected to be half factually true and half factually false, but communicating largely unknown information (Mattavelli et al., 2023). In Experiment 1, participants underwent both the exposure and judgment phase of the standard truth effect paradigm with sentences presented (in both phases) in either the declarative or the interrogative form. Experiment 2 was designed to test whether using a question form only at the time of processing (i.e., exposure), could moderate the truth effect. Experiment 3 manipulated sentence form and repetition in a full-within-subject design, aiming at proving whether the hypothesized reduced effect of repetition with questions depends on the context prompting participants to be more doubtful and analytical.

Open science

The experiments were preregistered on Open Science Framework (Experiment 1: <https://osf.io/492cv/>; Experiment 2: <https://osf.io/35wn4/>; Experiment 3: <https://osf.io/cw5hx/>). The power analyses, materials, data, and analysis code for the two experiments are available on Open Science Framework (Experiment 1: <https://osf.io/w8ab2/>; Experiment 2: <https://osf.io/4xas2/>; Experiment 3: <https://osf.io/fsduz/>). We have thus far conducted no other experiments on this research question. We report all manipulations and measures used in the two experiments.

Experiment 1

Experiment 1 explored whether presenting repeated information in an interrogative form moderates the truth effect. Our manipulation introduced two major changes from Calvillo and Harris (2023). Firstly, sentence form was manipulated between participants. Secondly, in both the conditions, sentence form remained constant in the exposure and in the judgment phases. This was done to establish whether the

hypothesized reduced truth effect in the interrogative condition resulted from lower truth assigned to repeated-interrogative (vs. repeated-declarative) information. Additionally, the study employed largely unknown trivia sentences.

Method

We adopted a 2 (sentence form: declarative vs. interrogative) \times 2 (sentence repetition: repeated vs. new) \times 2 (sentence factual truth: true vs. false) mixed design, with the first factor manipulated between subjects. Truth ratings were our outcome variable.

Sample-size determination

The study was powered on the interaction effect between sentence form and sentence repetition. We conducted a Monte Carlo simulation on SuperPower (Lakens & Caldwell, 2021, see <https://osf.io/w8ab2/> for details). In a 2 (sentence form: declarative vs. interrogative) \times 2 (sentence repetition: repeated vs. new) mixed analysis of variance (ANOVA) design, at $\alpha = 0.05$, the analysis indicated that collecting 200 participants allowed the detection of an effect as small as Cohen's $f = 0.40$ ($\eta^2 = 0.039$) at a power $1 - \beta > 0.90$. As sentence factual truth has repeatedly shown not to influence the truth effect (e.g., Corneille et al., 2020; Mattavelli et al., 2023), we included it only as a method factor in the design. We adopted (and preregistered) a sequential analysis approach (Lakens, 2014). We planned to conduct a single interim analysis. Thus, using the Pocock boundary (Pocock, 1992) to set the α level, we stopped the data collection when 100 participants had been collected, and conducted our analysis. As the critical test was $p < 0.0294$, we stopped our data collection.¹

Procedure

One hundred (59 women, 40 men, one nonspecified, $M_{\text{age}} = 37.39$ years, $SD_{\text{age}} = 5.24$) valid participants (five participants failed to complete the entire session) were recruited via Prolific Academic and paid for their participation. Five screening criteria were applied: participants were English speakers, declared living in the USA, with an approval rate of at least 95%, with at least 100 previous submissions on

¹ Although this boundary is commonly used for normally distributed variables across two treatment groups, it can also be applied to F tests, given that F tests with 1 numerator degree of freedom for main effects and interactions are mathematically equivalent to t tests. Additionally, we recognize that the maximum sample size in group sequential designs is generally larger than in fixed-sample tests. In our study, while the interim analysis allowed for potential early stopping, the power analysis was based on the maximum sample size associated with a fixed-sample approach. This may result in slightly lower power in practice due to the potential inflation in sample size.

Prolific, and not having taken part in previous related studies (Studies 1–3 from Mattavelli et al., 2024a). The experiment was programmed in Inquisit 6. After demographic information had been entered, participants were randomly assigned to either a declarative or an interrogative sentence repetition condition. Participants assigned to the declarative condition underwent an exposure phase in which a series of 20 (i.e., 10 true and 10 false) sentences randomly selected for each participant from a set of 40 (i.e., 20 true and 20 false) sentences used in Corneille et al., (2020; e.g., “The largest lithium deposits in the world are located in Bolivia”) appeared individually on screen. Each sentence was sequentially presented onscreen for 2,500 ms each, with a 1,000-ms break between sentences. The timing of the exposure phase was chosen based on other truth effect studies (Corneille et al., 2020; Mattavelli et al., 2023, Mattavelli et al., 2024a; Mattavelli et al., 2024b). During the exposure phase, participants were simply asked to pay attention to the sentences presented on the screen. Next, participants were introduced to the judgment phase. In this phase, participants saw a list of 40 sentences, half true and half false, appearing sequentially onscreen in random order. Participants were explicitly informed that the 40 sentences included both the sentences presented in the previous phase and novel sentences. Their task was to evaluate each sentence on truth (i.e., “To what extent do you believe this statement is true?”) on a scale ranging from 1 (*completely false*) to 6 (*completely true*). This continuous, as opposed to binary, response format was chosen in line with recent research investigating the truth effect with trivial sentences (e.g., Hassan & Barber, 2021; Hatzidaki et al., 2024; Nadarevic & Erdfelder, 2025). Sentences remained onscreen until participants responded. The next trial was presented after a break of 1,000 ms. Participants in the interrogative condition underwent the same two phases (i.e., exposure and judgement) with the sole exception that sentences were presented in interrogative form (e.g., “Are the largest lithium deposits in the world located in Bolivia?”). In the interrogative condition, we decided to present sentences in the interrogative form also in the judgment phase because we wanted the two between-subject conditions to have both repeated and new sentences presented as questions (see Supplementary Materials, Appendix A, for the exact instructions). Finally, participants were thanked for their participation.

Results

For this and for the following experiments, we conducted a linear mixed model with the “lmer()” function in R, to examine the effects of sentence form, sentence repetition, and the interaction term (i.e., fixed effects) on truth, with a random intercept for subjects. Although we preregistered the use of “aov_ez()” for this analysis, in deviating from

the preregistered protocol, our approach remains equivalent because we only included a random intercept for subjects, making the two methods mathematically comparable (see Supplementary Materials, Appendix B). Fixed effects were tested using ANOVA-like F tests, with degrees of freedom estimated using the Satterthwaite approximation. We conducted a Bayesian 2×2 mixed ANOVA using JASP (Version 0.17.2; JASP Team, 2023). The default priors for fixed effects (including the interaction) were Cauchy distributions centered at 0 with a scale of 0.5, as described by Rouder et al. (2012). Exploratory analyses were performed on reaction times.

Truth (preregistered)

We found a main effect of sentence form, $F(1,98) = 26.44$, $p < 0.001$, $\eta^2 = 0.30$. Sentences presented in the declarative form were judged more true ($M = 4.15$, $SD = 0.84$) than those presented in the interrogative form ($M = 3.61$, $SD = 0.54$). The effect of sentence repetition was significant, $F(1,98) = 38.61$, $p < 0.001$, $\eta^2 = 0.43$, indicating that repeated sentences were judged more true ($M = 4.13$, $SD = 0.85$) than novel sentences ($M = 3.65$, $SD = 0.56$). The interaction term was significant, $F(1,98) = 23.12$, $p < 0.001$, $\eta^2 = 0.26$. The Bayesian analysis supported the hypothesis of an interaction effect, $BF_{10} > 10$.³ The effect of repetition was significant in the declarative condition, $t(51) = -6.29$, $p < 0.001$, $d = 0.87$, but not in the interrogative condition, $t(47) = -1.65$, $p = 0.106$, $d = 0.24$. Moreover, we found a significant difference across the two sentences’ form conditions in truth ratings for repeated, but not for new, sentences, $F(1,98) = 38.92$, $p < 0.001$, $\eta^2 = 0.28$, and $F(1,98) = 2.61$, $p = 0.11$, $\eta^2 = 0.03$, respectively (see Fig. 1).

Reaction times (preregistered)

We found a main effect of sentence repetition, $F(1,98) = 34.25$, $p < 0.001$, $\eta^2 = 1.00$, indicating faster responses for repeated ($M = 4036$, $SD = 1962$) as opposed to novel ($M = 4757$, $SD = 1721$) sentences. No other effect was significant (p values > 0.86).

Discussion

Experiment 1 showed that sentence form moderated the effect of repetition on truth (while no interaction was found on reaction times). This moderation was reflected by a difference in truth assigned to repeated sentences across the two conditions, whereas nothing changed for new sentences. Participants displayed the typical truth effect when

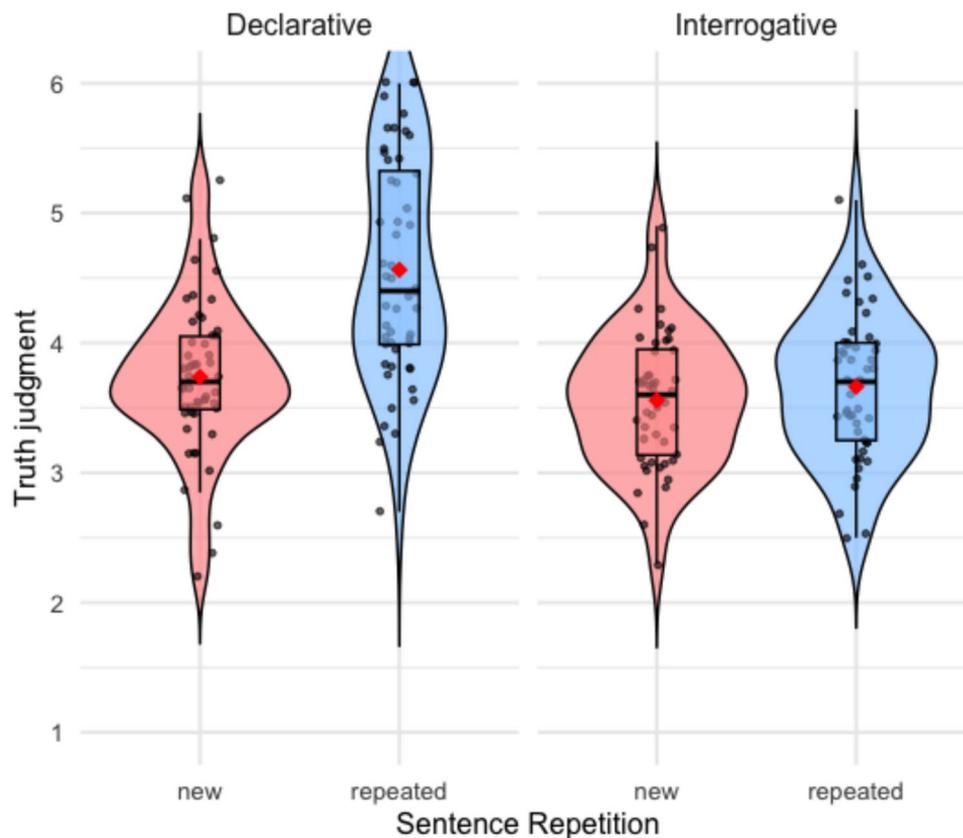


Fig. 1 Truth judgments for repeated versus new sentences in the two sentence form conditions in Experiment 1. The boxes are the interquartile range, the bars represent the median, and the red diamonds represent the mean. (Color figure online)

presented with sentences in a declarative form, yet this effect was absent when the same information was presented as questions. However, as the experiment was powered on the interaction term, stopping the data collection after collecting 100 participants left us with a sample that might have been underpowered to detect the effect of repetition on truth in the interrogative condition.

Moreover, Experiment 1 does not clarify whether the observed moderation stems from differences in processing sentence content during exposure or a variance in the judgment phase outcome variable. One possibility is that participants in the interrogative condition encountered challenges in determining the truth of information presented in question format. Addressing these concerns, Experiment 2 was designed to provide further insights on the moderating effect of sentence form.

Experiment 2

Experiment 2 was designed to replicate the moderating effect of sentence form on the truth effect and test whether the hypothesized reduced effect in the interrogative condition

would vary depending on whether information is processed in question form (a) both at exposure and judgment or (b) only at exposure. In Experiment 2, the standard truth effect paradigm (i.e., declarative condition) was compared with two alternative interrogative conditions. One condition (i.e., full interrogative) was identical to that employed in Experiment 1. The other (i.e., exposure-only interrogative) consisted of sentences presented in the interrogative form in the exposure, but not in the judgment phase.

Method

We adopted a 3 (sentence form: declarative vs. full interrogative vs. exposure-only interrogative) \times 2 (sentence repetition: repeated vs. new) \times 2 (sentence factual truth: true vs. false) mixed design, with the first factor manipulated between subjects. Truth ratings were our outcome variable.

Sample-size determination

We powered the study on the difference in the truth effect (i.e., average difference of “repeated” minus “new”

sentences, collapsed across factual truth) observed in two critical contrasts. The first contrast concerned the comparison between the declarative condition (– 2) with the average effect observed in the full interrogative (+ 1) and exposure-only interrogative (+ 1) conditions. In the second, we tested whether a difference in the truth effect existed between full interrogative versus exposure-only interrogative conditions (the declarative condition was excluded by assigning 0 to it). We aimed at a sample size that could allow us to detect two effects as small as Cohen's $f = 0.20$ ($\eta^2 = 0.039$). We used the *pwr* package in R to estimate the number of participants required in each cell, at $\alpha = 0.05$, and power $1 - \beta = 0.90$ (to obtain an actual power = 0.90, the nominal power of each contrast was adjusted to 0.95, see <https://osf.io/4xas2/> for details). The analysis suggested 108 participants per group, leading to 324 total participants. We adopted a sequential analysis approach (Lakens, 2014) and planned a single interim analysis ($N = 162$). As after our interim analysis the second planned contrast did not reach significance ($p > 0.0294$), we collected the remaining half of the sample.

Procedure

Three hundred and twenty-five (155 women, 169 men, one nonspecified, $M_{\text{age}} = 41.50$ years, $SD_{\text{age}} = 13.99$) valid participants (11 participants failed to complete the entire session) were recruited via Prolific Academic and paid for their participation. The same screening criteria used in Experiment 1 were applied. The experiment was programmed in Inquisit6. After demographic information had been entered, participants were randomly assigned to one of the three sentence form conditions. The procedure in the declarative and full interrogative conditions mirrored that employed in Experiment 1. Participants in the exposure-only interrogative condition saw sentences in the interrogative form only in the exposure phase (see Supplementary Materials, Appendix A, for the exact instructions). We employed the same sentences used in Experiment 1. Finally, participants were thanked for their participation.

Results

From the 3 (sentence form: declarative vs. full interrogative vs. exposure-only interrogative) \times 2 (sentence repetition: repeated vs. new) mixed ANOVA design, we computed two contrasts capturing (a) the comparison between the declarative condition and both the full interrogative and the exposure-only interrogative conditions and (b) the comparison between the full interrogative versus exposure-only interrogative conditions (without considering the declarative condition). We conducted a lineal mixed

model to examine the effects of the two contrasts, sentence repetition, and the interaction terms (i.e., fixed effects) on truth, with a random intercept for subjects. Fixed effects were tested using ANOVA-like F tests, with degrees of freedom estimated using the Satterthwaite approximation. A Bayesian ANOVA was conducted in JASP to examine the interaction effects of sentence repetition and the two contrasts on truth judgments. The prior inclusion probabilities for all terms were set to 0.5, and a fixed effects scale of 0.5 was used for each term, reflecting a balanced assumption about the likelihood of each effect. Exploratory analyses were performed on reaction times.

Truth (preregistered)

We found a main effect of sentence form when comparing the declarative ($M = 4.17$, $SD = 0.98$) and the two (averaged) interrogative ($M = 3.76$, $SD = 0.57$) conditions (i.e., first contrast), $F(1,322) = 47.54$, $p < 0.001$, $\eta^2 = 0.18$, whereas no main effect of sentence form emerged when comparing the two interrogative conditions (i.e., second contrast), $F(1,322) = 0.15$, $p = 0.698$, $\eta^2 = 0.001$. There was a main effect of sentence repetition, $F(1,322) = 128.88$, $p < 0.001$, $\eta^2 = 0.48$, indicating that repeated sentences were judged as more true ($M = 4.16$, $SD = 0.81$) than new sentences ($M = 3.64$, $SD = 0.60$). The interaction between repetition and the first contrast (i.e., effect of repetition in the declarative condition vs. averaged effect of repetition across the two interrogative conditions) was significant, $F(1,322) = 92.41$, $p < 0.001$, $\eta^2 = 0.34$. The effect of repetition was stronger in the declarative, $t(109) = 10.93$, $p < 0.001$, $d = 1.04$, than across the two interrogative conditions, $t(214) = 4.62$, $p < 0.001$, $d = 0.31$ (see Fig. 2). Bayesian analysis supported the hypothesis of a difference in the truth effect for the declarative condition as opposed to the two interrogative conditions, $BF_{10} = 40.94$. The interaction between repetition and the second contrast (i.e., effect of repetition in the full vs. exposure-only interrogative condition) was not significant, $F(1,322) = 2.20$, $p = 0.139$, $\eta^2 = 0.01$. The Bayesian analysis yielded evidence against a difference in the truth effect across the two interrogative conditions, $BF_{10} = 0.43$. Confirming Experiment 1, the difference between the affirmative and the interrogative conditions was limited to truth assigned to repeated statements, $F(1,323) = 114.50$, $p < 0.001$, $\eta^2 = 0.26$, whereas no difference was found for new sentences, $F(1,323) = 0.54$, $p = 0.462$, $\eta^2 = 0.002$.

Reaction times (preregistered)

We found a main effect of sentence repetition, $F(1,322) = 88.97$, $p < 0.001$, $\eta^2 = 0.94$, indicating faster responses

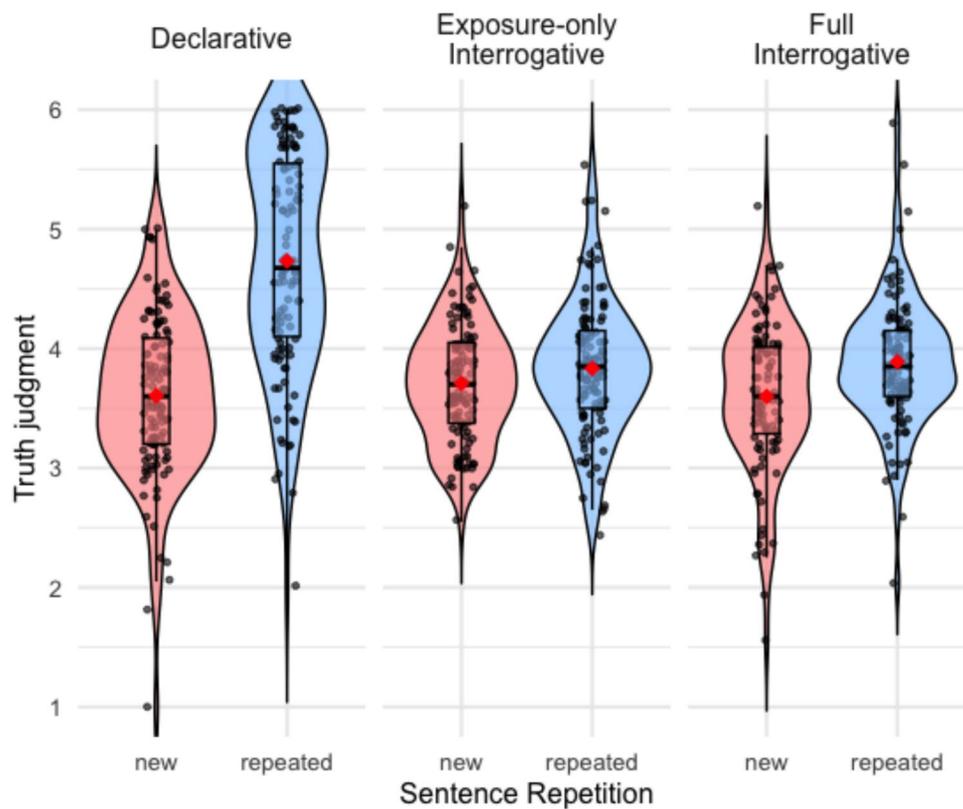


Fig. 2 Truth judgments for repeated vs new sentences in the three sentence form conditions in Experiment 2. The boxes are the interquartile range, the bars represent the median, and the red diamonds represent the mean. (Color figure online)

for repeated ($M = 3,975$, $SD = 2,115$) as opposed to novel ($M = 4,855$, $SD = 2,619$) sentences. No other effect reached significance (p values > 0.052).

Discussion

In Experiment 2, we replicated the moderating impact of sentence form on the truth effect (and no evidence of a significant interaction on reaction times). Differently from Experiment 1, with a high-sensitivity test, we showed that the simple effect of repetition was significant for sentences processed in the interrogative form, although the magnitude of this effect was far smaller compared with the declarative condition. Importantly, no significant difference emerged when comparing the two interrogative conditions. The exposure-only interrogative condition was introduced to rule out the possibility that the significant interaction observed in Experiment 1 was driven by participants finding it more difficult to judge the truth value of questions compared with statements. Our findings clarify that when information is initially presented as a question but later evaluated for truth in its declarative form, the effect of repetition is (a) largely attenuated compared with the declarative condition and (b) similar to that of the full interrogative condition. This

suggests that the attenuation of the truth effect is driven by the processing of information in question form during the exposure phase.

Experiments 1–2 suggested that when information is framed as a question rather than a statement, participants are less likely to use repetition as a cue for truth. This effect was examined in a between-subjects design, where participants were only exposed to one sentence form (either all declarative or all interrogative). This approach does not fully capture the complexity of real-world information processing, where individuals often encounter a mixture of both declarative and interrogative statements. One possibility is that the uniformity of interrogative sentences in the between-subjects design may have amplified participants' tendency to doubt the truthfulness of the information. However, when interrogative and declarative sentences are intermixed, a different scenario seems plausible. For instance, presenting information in the interrogative form might lose its power; in other words, people might rely less on sentence form and use repetition as a cue for truth. Experiment 3 is designed to investigate this possibility in a within-subjects design, where all participants process repeated and new information presented in both sentence forms.

Experiment 3

Experiment 3 tested the interaction between sentence repetition and sentence form in a full-within-subject design. Before us, Calvillo and Harris (2023) tested a similar idea. The authors compared repeated information presented as either statements or questions in the exposure phase, and then presented these “old” sentences plus new sentences in the judgment phase. They found no evidence for a truth effect with old information presented as questions in the exposure phase. However, since the truth effect is derived from a comparison between new (declarative) and old (interrogative) information, by comparing repeated interrogative sentences to new declarative sentences, their design did not allow to set apart the effect of repetition from the effect of sentence form. This makes it unclear which variable, either repetition or sentence form, could account for their findings. To settle this, our experiment uses a fully crossed design, where participants are first exposed to both declarative and interrogative sentences, and then evaluate both repeated and new sentences of each type in the judgment phase.

In addition to measuring the interaction between repetition and sentence form in full within design, we introduced one dependent variable—namely, certainty about the truth judgment. Stump et al. (2024) have recently showed that repetition increases certainty about truth judgments. Introducing a direct measure of certainty in this study we aimed to test whether the effect of repetition on certainty changes depending on sentence format. One hypothesis is that participants get more uncertain about the truth of repeated interrogative information; alternatively, repetition might have comparable effect on certainty about information presented either as questions or statements.

Method

We adopted a 2 (sentence format: affirmative vs. interrogative) \times 2 (sentence repetition: repeated vs. new) within-subject design. Truth ratings and certainty were our outcome variables.²

Sample-size determination

We powered the study on the difference in the effect of repetition (i.e., average difference of “repeated” minus “new”) for declarative and interrogative sentence, which is virtually

² In the experiment, we also included an illusion of prior knowledge measure at the end of the procedure. Speckmann and Unkelbach (2024) found that subjects believe they have already encountered the information in the past when it is repeated. We tested whether this illusion was reduced when repeated information is presented in a question form. For the sake of brevity, we have reported the analysis on this measure in the Supplementary Materials. We anticipate that

identical to testing a 2 \times 2 interaction in a within design. We used the *pwr* package in R to estimate the number of sample size that could allow us to detect three interaction effects as small as Cohen’s $f = 0.125$ ($\eta^2 = 0.015$), at $\alpha = 0.05$ and power $1 - \beta = 0.90$ (the nominal power of each effect was adjusted to 0.9665, see <https://osf.io/fsduz/> for details).³ The analysis suggested 232 participants. We slightly oversampled and recruited 235 participants.

Procedure

Two hundred and thirty-five (133 women, 97 men, five unspecified, $M_{\text{age}} = 40.27$ years, $SD_{\text{age}} = 11.87$) valid participants (10 participants failed to complete the entire session) were recruited via Prolific Academic and paid for their participation. The same screening criteria used in Experiments 1–2 were applied. The experiment was programmed in Inquisit6. After entering demographic information, participants completed an exposure phase where 20 sentences were presented on screen: 10 sentences were presented as statements, 10 as questions. Assignment of each sentence to one or the other version was random. Compared with Experiments 1–2, we prolonged the exposure timing for each sentence to 4,500 ms, maintaining a 1,000-ms break between trials: This was done to facilitate sentence processing and allow participants to remember what sentences were presented as questions versus statements. Next, in a judgment phase, participants judged the 20 old sentences plus 20 new ones (10 as questions and 10 as statements) for truth and certainty (see Supplementary Materials, Appendix A, for the complete instructions). Finally, participants were thanked for their participation.

Results

We conducted a lineal mixed model to examine the effects of sentence form, sentence repetition, and the interaction term (i.e., fixed effects) on both truth and certainty. Bayesian repeated-measures ANOVAs were conducted in JASP to quantify the strength of evidence for the interaction effects, using Bayes factors (BF) to compare models that included the interaction terms against models that exclude them (custom prior inclusion probabilities were set to 0.5 for all terms, with a fixed effect scale of 0.5 to balance the assumptions about the likelihood of each effect.). Exploratory analyses

Footnote 2 (continued)

no significant interaction between sentence repetition and sentence form emerged on this outcome variable.

³ Illusion of prior knowledge was included as third dependent variable, in addition to truth and certainty, in this analysis.

were performed on reaction times and reported in the Supplementary Materials.

Truth (preregistered)

We found a main effect of sentence form, $F(1,702) = 29.92$, $p < 0.001$, $\eta^2 = 0.32$. Sentences presented in the declarative form were judged more truthful ($M = 3.54$, $SD = 0.75$) than those presented in the interrogative form ($M = 3.36$, $SD = 0.68$). The effect of sentence repetition was significant, $F(1,702) = 56.83$, $p < 0.001$, $\eta^2 = 0.61$, indicating that repeated sentences were judged more true ($M = 3.57$, $SD = 0.77$) than novel sentences ($M = 3.33$, $SD = 0.64$). The interaction term was significant, $F(1,702) = 6.56$, $p = 0.010$, $\eta^2 = 0.07$. The Bayesian analysis supported the hypothesis of an interaction effect, $BF_{10} = 38.96$. The effect of repetition was significant in the declarative condition, $t(234) = -6.69$, $p < 0.001$, $d = 0.31$, and in the interrogative condition, $t(234) = -3.50$, $p < 0.001$, $d = 0.16$. Different from the previous studies, we found a significant difference across the two sentences' form conditions in truth ratings for both repeated and new sentences, $t(234) = 6.58$, $p < 0.001$, $d = 0.30$, and $t(234) = 2.22$, $p < 0.027$, $d = 0.10$, respectively (see Fig. 3).

The correlation between the effect of repetition on truth for sentences presented in the declarative and in the interrogative form was significant, $r = 0.30$, $t(233) = 4.79$, $p < 0.001$.

Certainty (preregistered)

We found a main effect of sentence form, $F(1,702) = 18.38$, $p < 0.001$, $\eta^2 = 0.24$. Participants were more certain about the truth value assigned to sentences presented in the declarative ($M = 2.89$, $SD = 0.98$) than in the interrogative form ($M = 2.74$, $SD = 0.95$). The effect of sentence repetition was significant, $F(1,702) = 48.01$, $p < 0.001$, $\eta^2 = 0.63$, indicating that repeated sentences were judged with higher certainty ($M = 2.93$, $SD = 1.01$) than novel sentences ($M = 2.70$, $SD = 0.91$). The interaction term was significant, $F(1,702) = 10.18$, $p = 0.001$, $\eta^2 = 0.13$. The Bayesian analysis supported the hypothesis of an interaction effect, $BF_{10} = 239.05$. The effect of repetition was significant in the declarative condition, $t(234) = -6.82$, $p < 0.001$, $d = 0.31$, and in the interrogative condition, $t(234) = -2.57$, $p = 0.011$, $d = 0.12$. (see Fig. 4).

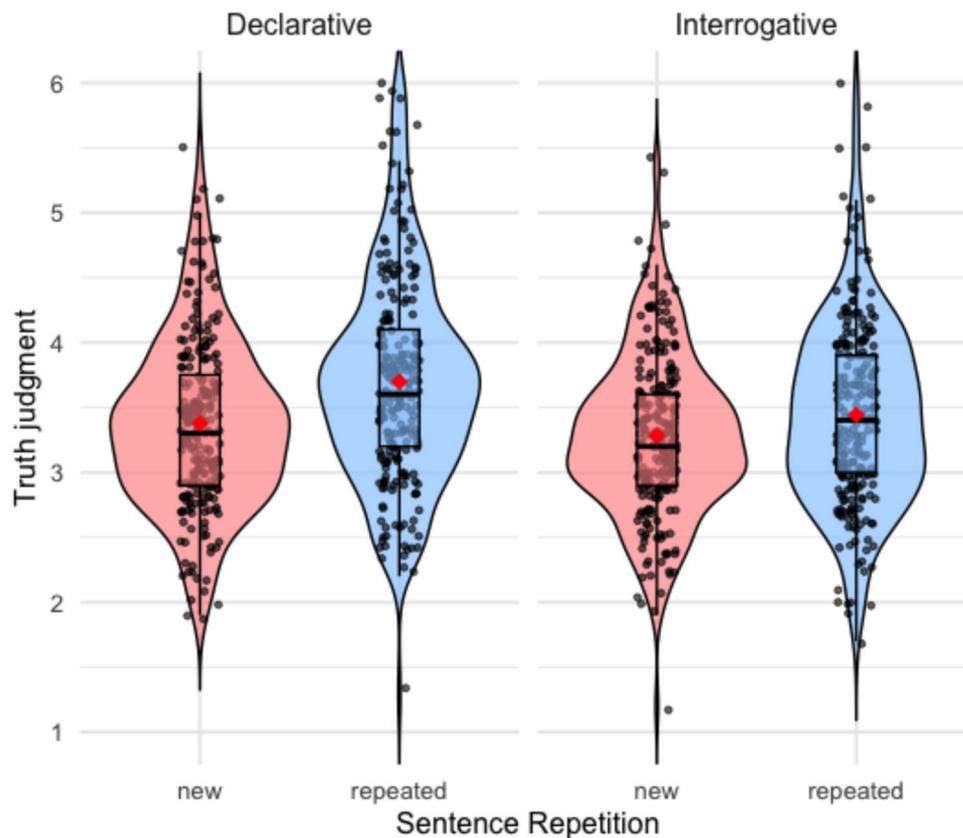


Fig. 3 Truth judgments for repeated versus new sentences based on sentence form in Experiment 3. The boxes are the interquartile range, the bars represent the median, and the red diamonds represent the mean. (Color figure online)

The correlation between the effect of repetition on certainty for sentences presented in the declarative and in the interrogative form was significant, $r = 0.20$, $t(233) = 3.10$, $p = 0.002$.

Correlation between repetition-induced truth and certainty (preregistered)

We also examined the correlation between the effect of repetition on truth and certainty for each participant. On both declarative and interrogative sentences, the two repetition scores were significantly and positively correlated, $r = 0.59$, $t(233) = 11.25$, $p < 0.001$ and $r = 0.54$, $t(233) = 9.67$, $p < 0.001$, respectively.

Finally, since both truth and certainty ratings were provided using the same Likert scale (1–6), we considered the possibility that truth judgments were influenced by certainty ratings. To test this, we recoded the truth scores: responses near the scale's center (i.e., 3 and 4) were assigned a score of 1, intermediate scores (i.e., 2 and 5) a score of 2, and extreme scores (i.e., 1 and 6) a score of 3. This recoding allowed us to derive an indirect measure of certainty from truth ratings. We then correlated these scores with actual

certainty ratings, finding a positive and significant correlation ($r = 0.47$, $p < 0.001$). This modest correlation suggests that the two measures, while not redundant, are related, possibly indicating that truth judgments measured on a continuous scale may partly reflect participants' confidence in their assessments, especially in cases where respondents are unsure about the veracity of the information. Future research may benefit from a binary truth measure and an independent confidence rating to more precisely disentangle perceived truth from judgmental certainty.

Discussion

Experiment 3 showed that the moderating impact of sentence form on the truth effect is confirmed even in a context where participants are presented with a mixture of questions and statements during the exposure phase. Confirming Experiment 2, a small, but significant, truth effect was detected for information presented in the interrogative form. Interestingly, in this within-subject design, we found the truth effect for interrogative sentences to be similar compared with the one observed across the two previous studies, where sentence form was manipulated between participants; instead,

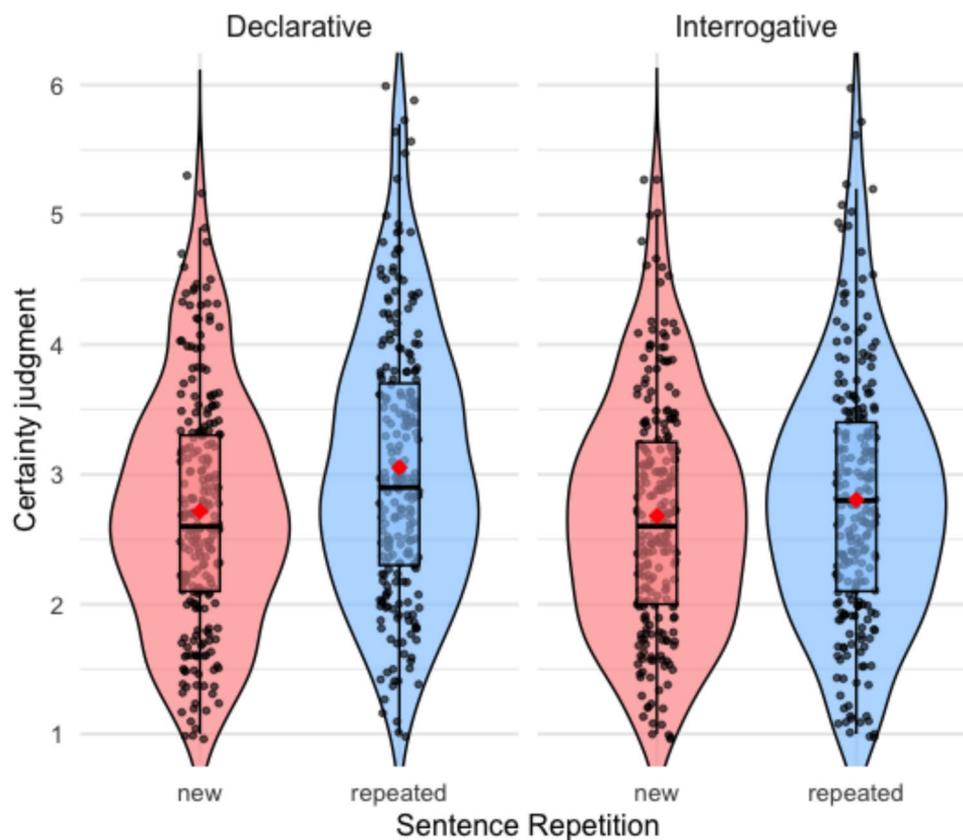


Fig. 4 Certainty judgments for repeated versus new sentences based on sentence form in Experiment 3. The boxes are the interquartile range, the bars represent the median, and the red diamonds represent the mean. (Color figure online)

the truth effect on declarative sentences appeared largely reduced (we will return to this in the next paragraph). The analysis on certainty about the truth value assigned to sentences showed that the effect of repetition was also reduced when such sentences were in the interrogative form.

General discussion

Three experiments explored the effect of questions in reducing the truth effect in the absence of information knowledge. In Experiment 1, we assigned participants to either a standard condition of the truth effect paradigm or a condition in which sentences were presented in question form, in both the exposure and judgment phase. Sentences' form moderated the truth effect. A standard repetition-induced truth effect was found for declarative sentences, while the same effect did not reach significance for questions. Experiment 2 was a highly powered study that introduced an additional interrogative condition, with sentences presented to participants in the form of questions in the exposure but not the judgment phase. With a bigger sample, we found that the truth effect was still reduced, but significant, in the two interrogative conditions (as opposed to the declarative condition). A direct comparison between the two interrogative conditions revealed no significant difference. Experiment 3 extended our investigation by employing a full within-subjects design, which allowed us to directly compare the effects of repetition and sentence form on truth judgments within the same individuals. We found a significant interaction between sentence form and repetition: While the truth effect remained for both declarative and interrogative sentences, it was notably smaller for questions than for statements. Moreover, the effect of repetition on certainty about interrogative sentences was significantly reduced when compared with the one observed with statements.

Our studies showed that the positive relationship between repetition and truth was largely reduced when sentences were processed in an interrogative form. Because we used largely unknown statements, this reduced effect cannot be interpreted in terms of questions cueing accuracy (see Calvillo & Harris, 2023).

What, then, induced participants to rely less on repetition when information was presented in the form of questions, as opposed to statements? Experiment 3 explored the possibility that individuals might be less certain about the truth value of the content of repeated questions, as opposed to repeated statements. In essence, turning the statement "The largest lithium deposits in the world are located in Bolivia" into a question (i.e., "Are the largest lithium deposits in the world located in Bolivia?") might have induced participants to generate possible alternatives (e.g., "The largest lithium deposits in the world are located in Australia"),

that ultimately made the original sentence less likely to be true. Our results showed that while repetition still enhances certainty for interrogative sentences, this effect is weaker than for declarative sentences (and anecdotal, as revealed by Bayesian analyses). This reduced repetition-induced certainty with questions could explain why repetition also had a smaller impact on the truth effect. Namely, when people are less certain about the information they encounter, they may be more hesitant to rate it as true, even when repetition increases its familiarity. In the case of questions, the interrogative form may have prompted more doubt or critical thinking, leading participants to reconsider the truth of the information more carefully, thereby dampening the effect of repetition. However, this finding should be interpreted with caution. As the data are correlational, we cannot definitively conclude that reduced certainty directly causes the reduced truth effect. Other factors, such as the increased cognitive engagement required by interrogative sentences, may also play a role. Further research, possibly with experimental manipulations, is needed to more clearly establish the causal mechanisms underlying the moderating impact of sentence form of the truth effect.

These findings provide critical insights into the theoretical underpinnings of the truth effect. Take, for instance, the referential theory of the truth effect proposed by Unkelbach and Rom (2017). This theory suggests that repetition strengthens associative links in memory. When a new statement (e.g., "The largest lithium deposits in the world are in Australia") is encountered, it activates related memory references. Understanding the statement instigates the statement's corresponding memory references, which then consolidate into a referential network. Repeated exposure reinforces these links, making the statement more coherent and, consequently, more believable. The authors further argued that the strength of this network depends on how the units within the encountered statement are linked. For example, in "The largest lithium deposits in the world are in Australia," the words "largest," "lithium deposit," "world," and "Australia" are connected by excitatory links. However, when the same information is presented as a question ("Are the largest lithium deposits in the world in Australia?"), these links are likely weaker, less capable of generating units' activation. This suggests that sentences, when presented as questions rather than statements, might form weaker memory associations, leading to a reduced truth effect. However, this hypothesis remains speculative at this stage and further research is needed to clarify the role of variables such as memory and network coherence in shaping the interplay between repetition and sentence form.

To further investigate the cognitive mechanisms responsible for the truth effect, in Experiments 1 and 2, we measured reaction times during the judgment phase to examine whether repeated information presented in an interrogative

form loses its advantage in processing fluency (Clore, 1992). We found no evidence for this effect: Regardless of whether information was presented as statements or questions, repetition led to faster judgments (i.e., increased fluency).

This suggests that questioning does not weaken the truth effect by making repeated information harder to process at judgment. However, our findings indicate that merely presenting information in an interrogative form during the exposure phase is sufficient to attenuate the truth effect (Experiment 2). In our studies, sentences' onset during exposure phase was fixed (i.e., 2,500 ms in Experiments 1 and 2; 4,500 ms in Experiment 3), which prevents us from studying any potential difference in the amount of processing required by interrogative versus declarative information. Future research could investigate whether statements presented in an interrogative form during exposure lead to longer reaction times (indicative of deeper processing) and whether this correlates with a subsequent reduction in the truth effect.

Beyond any consideration about the mental explanations of the truth effect, finding that questions reduced the truth effect aligns with the ecological account (Unkelbach & Greifeneder, 2013), which posits that the link between repetition and truth is context-dependent (see Corneille et al., 2020). Namely, we argue that when it comes to a “questions ecology,” true information does not necessarily occur more often than false information. Under such conditions, the usual association between repetition and truth is reduced. This seems to indicate that an important component of the truth effect lies in the belief system. When the context justifies the validity of the belief informing about the positive link between repetition and truth, the truth effect is likely to occur. Conversely, when the context invalidates such a belief, the truth effect tends to be reduced.

The practical implications of finding a reduced but still significant effect of repetition on truth with information presented interrogatively are noteworthy. Fact-checking techniques that present fake news as questions without clear labels may not be as harmless as previously suggested. (Calvillo & Harris, 2023). In contrast with Calvillo and Harris (2023), who found no evidence for a truth effect with headlines presented as questions, our studies revealed a reduced, but still significant, truth effect in the interrogative condition. This was found using largely unknown information. Thus, in conditions of uncertainty about information's factual truth, when information is questioned people seem to still succumb to repetition-induced truth.

Moreover, the power of questions in reducing the truth effect should be examined long term. Memory is indeed an important variable that should be taken into consideration when studying the truth effect. On the one hand, whereas the truth effect persists after weeks (Bacon, 1979; Hasher et al., 1977), more recent evidence indicates that it is influenced

by the retention interval, with the effect diminishing as delay increases (Henderson et al., 2021; Stump et al., 2022). This could, for instance, imply that a truth effect that is small to begin with, like the one we observed on interrogative information, might fade away over time. On the other hand, past research has shown that under certain conditions (i.e., comprehensibility of information), questions can be misremembered as statements (Pandelaere & Dewitte, 2006). This could be expected because, after a longer delay, the role of memory and recognition in informing truth should outperform that of alternative cues (e.g., sentence form). Under this view, it seems plausible that the small truth effect might increase over time. Future studies should better explore the role of time and memory on the truth effect with interrogative information.

That said, our data seem to suggest that the truth effect for declarative sentences was reduced when sentence form was manipulated within participant (Experiment 3), compared with when participants were exposed only to one type of sentence form throughout the study (Experiments 1–2; see Supplementary Materials, Appendix B, for an aggregated analysis). This might suggest that the mere presence of questions at any stage (i.e., exposure or judgment) may be sufficient to moderate the truth effect. This might happen because introducing interrogative information might induce participants to be more doubtful, or unsure, about the truth of information presented in the declarative form. However, the shift from a between-subjects to a within-subjects design was not the only change introduced in Experiment 3. For instance, the addition of a certainty measure may have led participants to be less confident in their truth judgments. While we find the attenuation of the truth effect for declarative sentences intriguing, we refrain from drawing definitive conclusions about the mechanisms behind this effect. Future research should explore this intriguing possibility by systematically varying when and how questions are introduced in the truth judgment process. Such studies could help delineate whether the reduction in the truth effect is driven by the initial encounter with interrogative sentences, or if the question format at any stage is enough to weaken the link between repetition and perceived truth.

Conclusion

Across three experiments, we found that altering sentence form from declarative to interrogative leads to a significant decrease in the effect of repetition on truth. When repeated sentences were initially processed in an interrogative format, participants were more likely to treat repetition as a cue for falsity, as compared with when sentences were processed in the standard declarative form. Thus, questioning is a promising way for mitigating the truth effect, although it does not eliminate it. The fact that a smaller, but still significant, truth

effect was found in the interrogative form suggests that, in the absence of alternative truth-relevant cues (e.g., knowledge information factual truth), repetition is still partly used as a cue for truth.

Supplementary Information The online version contains supplementary material available at <https://doi.org/10.3758/s13421-025-01742-9>.

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Data availability Data and analysis code are publicly available on Open Science Framework (Experiment 1: <https://osf.io/w8ab2/>; Experiment 2: <https://osf.io/4xas2/>; Experiment 3: <https://osf.io/fsduz/>).

Code availability The Inquisit scripts are available on Open Science Framework (Experiment 1: <https://osf.io/w8ab2/>; Experiment 2: <https://osf.io/4xas2/>; Experiment 3: <https://osf.io/fsduz/>).

Declarations

Ethics approval The methodology for these studies was approved by the University Ethics Committee of the Department of Psychology, University of Milano-Bicocca.

Consent to participate Informed consent was obtained from all participants included in the study.

Consent for publication No identifying information of any participants is included in this manuscript.

Conflicts of interest The authors have no conflict of interest to declare.

Open practice statement The experiments were preregistered on Open Science Framework (Experiment 1: <https://osf.io/492cv/>; Experiment 2: <https://osf.io/35wn4/>; Experiment 3: <https://osf.io/cw5hx/>). The materials, data, and analysis code for the two experiments are available on Open Science Framework (Experiment 1: <https://osf.io/w8ab2/>; Experiment 2: <https://osf.io/4xas2/>; Experiment 3: <https://osf.io/fsduz/>).

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