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How Stories in Memory Perpetuate the Continued Influence of False Information

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Abstract

People often encounter information that they subsequently learn is false. Past research has shown that people sometimes continue to use this misinformation in their reasoning, even if they remember that the information is false, which researchers refer to as the *continued influence effect*. The current work shows that the continued influence effect depends on the stories people have in memory: corrected misinformation was found to have a stronger effect on people's beliefs than information that was topically related to the story if it helped to provide a causal explanation of a story they had read previously. We argue this effect occurs because information that can fill a causal "gap" in a story enhances comprehension of the story event, which allows people to build a complete (if inaccurate) event model that they prefer over an accurate but incomplete event model. This effect is less likely to occur for stories in memory that end in a negative way, presumably because people are more motivated to accurately understand negative-outcome events.

Keywords: mental models, misinformation, continued influence effect

Imagine a pharmaceutical advertisement that presents a testimonial of a consumer's experience using a drug. Such narratives are often followed by a list of factual information about the drug, including benefits, possible side effects, and potential interactions with other drugs. Now imagine that a piece of this information about the drug is later retracted or publicly discredited. Could the consumer testimonial which preceded the discredited information make a difference in whether the information continues to influence viewers' beliefs?

Past work shows that information initially presumed to be correct, but later retracted or corrected, often continues to influence memory and reasoning, and that this occurs even if the retraction itself is remembered (Chan, Jones, Jamieson & Albarracín, 2017; Johnson & Seifert, 1994; Lewandowsky, Ecker, Seifert, Schwarz, & Cook, 2012; Rich & Zaragoza, 2016). This is known as the *continued influence effect* (CIE) of misinformation, and has relevance for work on corrective advertising and consumer wellbeing (Bernhardt, Kinnear, & Mazis, 1986; Darke, Ashworth, & Ritchie, 2008; Tangari, Kees, Andrews, & Burton, 2010). For example, many consumers and health professionals persisted in their belief in a connection between autism and childhood vaccines despite the subsequent discrediting of the fraudulent study that initially suggested the relationship (Hargreaves, Lewis, & Speers, 2003).

One explanation that has been proposed to account for the continued influence effect is based on the way that people process information about events, or stories. As illustrated by recent work in marketing and consumer psychology, people process stories in ways that are distinct from the processing of argument-based messages (Escalas, 2004; 2007; van Laer, de Ruyter, Visconti, & Wetzels, 2014): readers build mental models of unfolding events or stories (Bower & Morrow, 1990; Johnson-Laird, 1983), and elements in the model are linked together in a cause-effect chain. Eliminating information from the model would create a "gap" that would render the model less complete (Johnson-Laird, 2012). Past work has hypothesized that (mis)information embedded in a story influences readers' reasoning and beliefs because people implicitly prefer a complete (but potentially incorrect) model of an event over a correct but incomplete model; that is, discrediting causal information embedded in an accepted cause-effect model can create an undesirable state of incompletion (Ecker, Lewandowsky, & Tang, 2010; Johnson & Seifert, 1994; Rich & Zaragoza, 2016; van Oostendorp & Bonebakker, 1999).

In the current work we examine the question: Does the continued influence effect occur for isolated information that can retrospectively explain a story in memory? On the one hand, information presented separately from a focal story may be easier to retract because it was not initially processed as part of a story (i.e., the retracted information does not need to be removed from the mental event model). On the other hand, certain types of information may be readily integrated into an existing mental event model in memory, rendering it resistant to retraction. Given the prevalence and influence of stories in marketing contexts and beyond (Escalas, 2004; 2007; Hamby, Brinberg & Daniloski, 2017; McFerran, Dahl, Gorn, & Honea 2010; van Laer, Feiereisen, & Visconti, 2019), this question is one of both theoretical and practical importance.

We show that consumers continue to believe retracted information if that information provides a retroactive causal explanation for a story in memory. By contrast, when a story in memory is already fully understood—thus minimizing the need to integrate new information into the existing model—or when the new information is only topically (versus causally) related to the story, consumers are less likely to believe and be influenced by the new information after its retraction. We extend past work by showing that the continued influence effect occurs for misinformation that is *added* to an existing mental model, and that misinformation can have consequences for choice behavior. We also identify a boundary condition: a negative story ending attenuates the continued influence effect, presumably because of the enhanced need for model accuracy.

Explanations for the Continued Influence of (Mis)information

In today's ever-transforming world, information is frequently outdated and people must update their memories accordingly. Because problems occur when people use outdated information, numerous scholars have tried to understand the causes of the continued influence effect, in which people apply retracted information to make inferences. In a seminal study, Johnson and Seifert (1994) presented participants with a news story about a warehouse fire (also see Wilkes & Leatherbarrow, 1988). The initial cause of the fire was presented as volatile materials stored haphazardly in a closet. Later, participants were told that the closet was actually empty (i.e., volatile materials did not cause the fire). Though participants remembered this retraction, they still used the outdated information to make inferences to explain the event. This continued reliance on corrected misinformation has been replicated with many types of news stories (e.g., Ecker, Lewandowsky, Swire, & Chang, 2011; Rich & Zaragoza, 2016).

Several explanations have been proposed for the continued influence effect, which may operate in conjunction. One explanation is based on the way that people rely on their subjective experience to determine truth values. Specifically, familiar information is more likely to be viewed as true (Pennycook, Cannon, & Rand, 2018; Weaver, Garcia, Schwarz, & Miller, 2007). Thus, if a correction targets a familiar myth, people may accept the myth as true despite the correction, based on its familiarity (Swire, Ecker, & Lewandowsky, 2017). Some scholars have even proposed that the mere retraction of information can enhance the familiarity of the false information because it is repeated in the retraction (Schwarz, Sanna, Skurnik, & Yoon, 2007; but see Ecker, Hogan, & Lewandowsky, 2017; Ecker, O'Reilly, Reid, & Chang, 2019).

Second, there is evidence for a retrieval failure explanation: processing retractions can be likened to attaching a negation tag to a memory (Gilbert, Tafarodi, & Malone, 1993), and if this negation tag is not retrieved alongside the misinformation, continued influence can occur (Ecker et al., 2011; Johnson & Seifert, 1998; Swire et al., 2017). Relatedly, interference may contribute to the CIE if that retrieval of the correction is hindered by proactive interference exerted by the initial misinformation (i.e., a primacy effect; see Ecker, Lewandowsky, Cheung, & Maybery, 2015). Kendeou and colleagues (2013) argued that information supporting the plausibility of the correction reduces interference arising from activation of misinformation. One reason that a primacy effect is observed (rather than a recency effect) may be that initial information is particularly well integrated into a developing mental model (Ecker et al., 2015).

Relatedly, a third explanation for the continued influence effect revolves around the way people build mental models of unfolding events (Johnson & Seifert, 1994; van Oostendorp & Bonebakker, 1999). Also known as narrative processing (Escalas, 2004), people build cause-effect structures to represent events or stories. For example, factor A (an illness) may lead to factor B (taking a medication) and factor B in conjunction with factor C (drinking orange juice to wash down the medication) may cause outcome D (an adverse effect due to the interaction of the medicine with the vitamin C in the orange juice). If a retraction denies a central piece of the story (e.g., vitamin C does not interact with the medicine), it will pose a challenge to the coherence of the mental model. Maintaining coherence thus requires effortful integration of new explanatory information into a revised mental model. Continued influence of the original

information can occur if this integrative revision fails (Gordon, Brooks, Quadflieg, Ecker, & Lewandowsky, 2017; Kendeou, Walsh, Smith, & O'Brien, 2014). Integration is facilitated if readers are supplied with an alternative causal explanation that can serve to replace the misinformation in the mental model. A correction that provides an alternative explanation is more effective than a retraction alone, as the latter poses a greater threat to model coherence (Ecker et al., 2010; Johnson & Seifert, 1994; van Oostendorp & Bonebakker, 1999). Thus, the continued influence of misinformation may arise as a direct consequence of the way people represent causal information in memory (Ecker et al., 2010; Johnson & Seifert, 1994; van Oostendorp & Bonebakker, 1999).

The notion that one's mental representation of information can impact one's memory and reasoning performance may also explain why research on the CIE seems to contrast to some extent with research on directed forgetting. The robust finding in this literature is that instructions to forget (vs. remember) information can lead individuals to selectively forget information. In other words, people's memory for information that is subsequently cued to be forgotten is impaired relative to information cued to be remembered (Horton & Petruk, 1980; MacLeod, 1975). A key difference between paradigms is that in directed-forgetting tasks, information is typically presented in decontextualized lists, with one of the lists cued to be forgotten. In contrast, retracted misinformation in a continued-influence paradigm is usually integrated in a narrative or cause-effect chain, which may make the misinformation more resistant to correction. This is supported by evidence that directed forgetting is more likely to fail if it is "selective," meaning it is easier to forget an entire list than selected items from a list (Storm, Koppel, & Wilson, 2013), and it is difficult to forget to-be-forgotten information that is thematically related to concurrently presented to-be-remembered material (Delaney, Nghiem, & Waldum, 2009).

Narrative Processing

It is increasingly important for marketers to understand narrative processing, given consumers' natural affinity for stories, their tendency to engage in less critical thinking when processing stories (Escalas, 2004; 2007), and the increased use of storytelling as a strategy in the digital era (van Laer, Feiereisen, & Visconti, 2019). Stories are prevalent in the lives of consumers and exert enduring influence on beliefs, attitudes, and behaviors (Escalas, 2004; 2007; van Laer et al., 2014; van Laer, Feiereisen, & Visconti, 2019). A great deal of research in the marketing and consumer literature has focused on narrative transportation—the reader's subjective experience of narrative processing (Green & Brock, 2000)—as a key predictor of story-related belief (Hamby, Brinberg & Daniloski, 2017; McFerran, Dahl, Gorn, & Honea 2010; van Laer et al., 2014; van Laer, Feiereisen, & Visconti, 2019). Less research in this stream has explored how structural aspects of the readers' story representation can influence their beliefs.

One recent exception is a study by van Laer, Escalas, Ludwig, and van den Hende (2019): they showed that narrative content related to spatial and temporal embedding influences consumers' transportation into the story and related beliefs. Time and space (along with causality, characters, and their motivations) are components of the mental model that readers construct to represent the content and setting for cause and effect relationships depicted in a narrative (Bower & Morrow, 1990; Johnson-Laird, 1983). Readers integrate incoming information into their mental model to make sense of actions, events, and character interactions, and create a higher-level representation that reflects the plotline (McKoon & Ratcliff, 1992). People store the mental model in long-term memory and may continue to revise it after the initial processing of a narrative (Zhang & Hoosain, 2001). As Zwaan and Radvansky (1998, p. 166) describe, "The complete model is not necessarily the final model. Comprehenders may ruminate over a narrative and generate additional inferences." For example, viewers of serialized narratives can integrate information contained in two episodes despite the temporal separation between viewings, and may continue to ponder the narrative even after the series finale.

A critical element of a complete and coherent mental model (one that "makes sense") is causality, or an understanding of cause-effect relationships in the story (Johnson-Laird, 2012). Many actions, states, and events described in narratives are organized around the cause-effect backbone of the narrative (Graesser, Singer, & Trabasso, 1994). Past work shows that narratives are recalled from memory in linear temporal cause-effect order, even when narrative information is originally presented in a disjointed temporal order (e.g., using flash-back and flash-forward scenes; Lichtenstein & Brewer, 1980), which illustrates the fundamental nature of causality in orienting story understanding.

Causality and the Persistence of Misinformation

Given (1) the basic desire to comprehend stories that are read (Graesser et al., 1994), (2) the importance of causality in constructing a mental story model, and (3) mental models may continue to be updated following initial construction, we propose that readers will integrate new information into their mental model of a story retrospectively if the information can fill a causal gap in that model. We also propose that people are more likely to resist retraction of such information if it helps them understand a story in memory (relative to when that same information does *not* help to understand a story in memory).

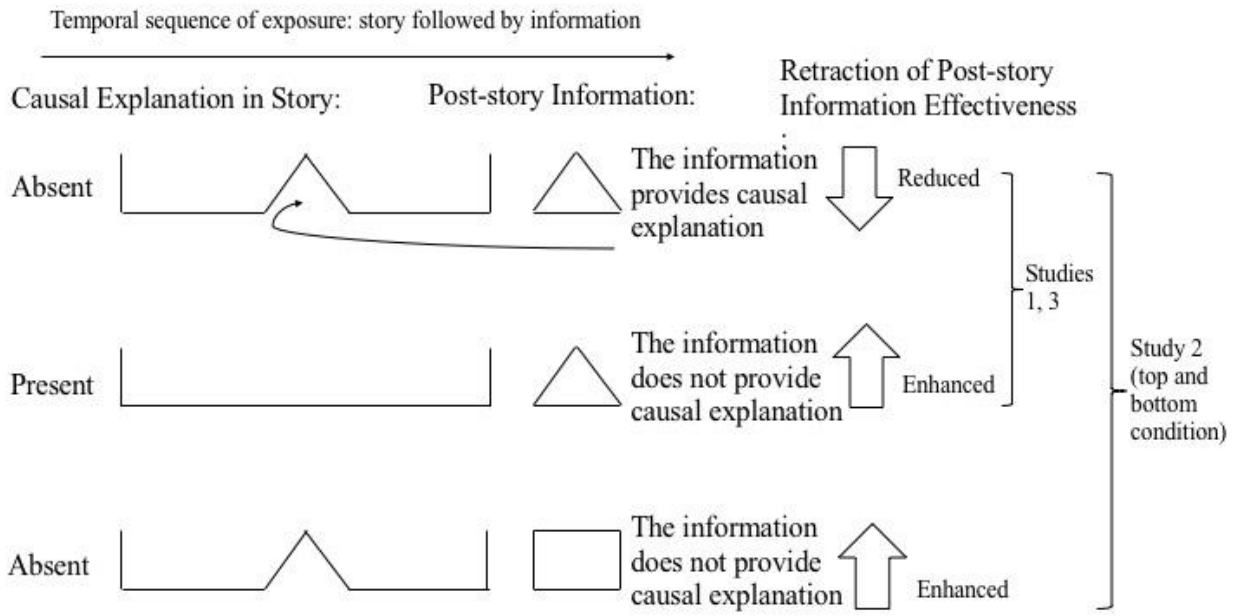
Using our prior example of an individual who takes a medication and experiences complications, there is no reason to initially believe that the complications are caused by the orange juice used to wash down the medication (the complications could be caused by another medication taken earlier, for example). Information encountered subsequent to initial exposure to the story ("vitamin C often interacts with medication to create complications") may be used as the basis for inferences about the story, leading to an updated model (orange juice contains vitamin C; vitamin C causes drug complications; the character's complications were probably due to the interaction between vitamin C and the drug). If the mental model explanation for the persistence of misinformation is correct, a retraction of the separate statement about vitamin C and drug complications should be of limited efficacy because the new information and its implications have been integrated into the model of the story.

Johnson and Seifert (1994) demonstrated that causal information in a story is resistant to retraction. The present study expands this work. A key difference in the current work lies in the relationship between the target information and the embedding context. In Johnson and Seifert's (1994) work, participants were presented with target information (e.g., volatile materials caused a warehouse fire) in the course of comprehending the story, where it would naturally be expected that participants would integrate it into their mental model of the event. Mentioning the materials incidentally in the story did not influence readers' responses; rather, "the volatile materials had to be *part of the story line* in order to show up in answers to questions about the fire" (italics original; Seifert, 2014, p. 45). Retraction efforts required participants to edit their original mental model.

Here, rather than examining how explanations *within* a story resist retraction, we examine the persistence of misinformation that is not part of the story but can be understood *with reference to* a story—a strict interpretation of Seifert's (2014) quote from the previous paragraph would suggest that misinformation that is not part of the original story should not affect continued influence, whereas the mental model account suggests that it should. The current work examines whether (1) readers will apply the mental effort needed to incorporate information following the online processing of a story into their mental model of the story, to the extent that the new information retrospectively facilitates story comprehension, and if so, (2) whether such information exerts continued influence if it is retracted. We propose that the effectiveness of information retraction depends less on the objective information itself, and more on its relationship to a story in memory (see Figure 1). Specifically, we propose:

> **H1**: Retracted information presented after a story will continue to influence reasoning, beliefs, and behavior when it provides a causal explanation for an event in a model that exists in memory, relative to when that same information does not provide a causal explanation for an event stored in memory.

Figure 1. Conceptual Model of Study Predictions.



Valence of Story Ending

The valence of a story's ending is a fundamental element of all stories, and may influence a consumer's motivation to maintain an up-to-date and accurate mental event model. Consumers respond to negative and positive information in distinct ways; consumers find negative information more vivid and diagnostic (Herr, Kardes, & Kim, 1991), and are more motivated to elaborate on negative information (MacInnis, Moorman, & Jawlorski, 1991). One reason for this effect is that negative information arouses a need to understand the related causes and effects, potentially as a way to forestall the consequences for consumers themselves (Moorman, 1990). This enhanced motivation will arguably boost strategic monitoring and critical thinking, which should reduce the CIE (see Ecker et al., 2010), in line with studies showing that individual differences related to critical thinking such as lower verbal intelligence and lower working memory capacity predict susceptibility to the CIE (Brydges, Gignac, & Ecker, 2018; De keersmaecker & Roets, 2017). Thus, when consumers learn that their causal understanding of a story in memory is incorrect (i.e., through exposure to a retraction), they may be more motivated to update their mental model when the story ends in a negative (versus positive) manner. We propose:

> **H2a**: The valence of the story ending will moderate the influence of the post-story information's causal relevance on the CIE: When the story ends in a positive manner, the CIE will be stronger when the retracted misinformation provides a causal explanation for an event in memory.
>
> **H2b:** When the story ends in a negative manner, the CIE will be reduced (i.e., the retraction will be equally effective) regardless of whether the retracted misinformation provides a causal explanation for an event stored in memory.

Overview of Studies

We conducted 3 studies to test our hypotheses. In Study 1, we held the post-story misinformation constant and manipulated the causal completeness of the story plotline presented beforehand. We expected that retracted misinformation would have a stronger influence on beliefs when presented after a story in which an explanation for a key story event was absent (i.e., when the post-story information could serve to explain the story) versus present (i.e., when an explanation was already given in the story). In Study 2, we held the story constant, but manipulated the misinformation presented after the story, such that it was either causally or only topically related to the plotline. We

replicated the findings of Study 1, and additionally examined the influence on product selection behavior. In Study 3, we showed that story-ending valence moderates the CIE: consumers were more receptive to a retraction when the story ended negatively (versus positively).

Study 1: Story Causality and the Persistence of Post-Story Misinformation

Study 1 used a delayed post-test design to examine whether continued influence occurs with post-story misinformation, and if it depends on whether the misinformation explains a story in memory. In this study, all participants viewed a story in which a character experiences drug complications. Some participants viewed a story that provided an explanation for the complications (explanation present), while other participants viewed a story that provided no explanation (explanation absent). All participants received post-story information that could potentially explain the character's complications; this information was subsequently retracted. We expected readers in the explanation-absent condition would continue to accept the post-story misinformation and use it to make inferences about the story despite its retraction, because this information would help to fill a gap in their mental model of the story. Readers in the explanation-present condition would have no causal gap to fill, and should be less likely to endorse the retracted misinformation.

Method

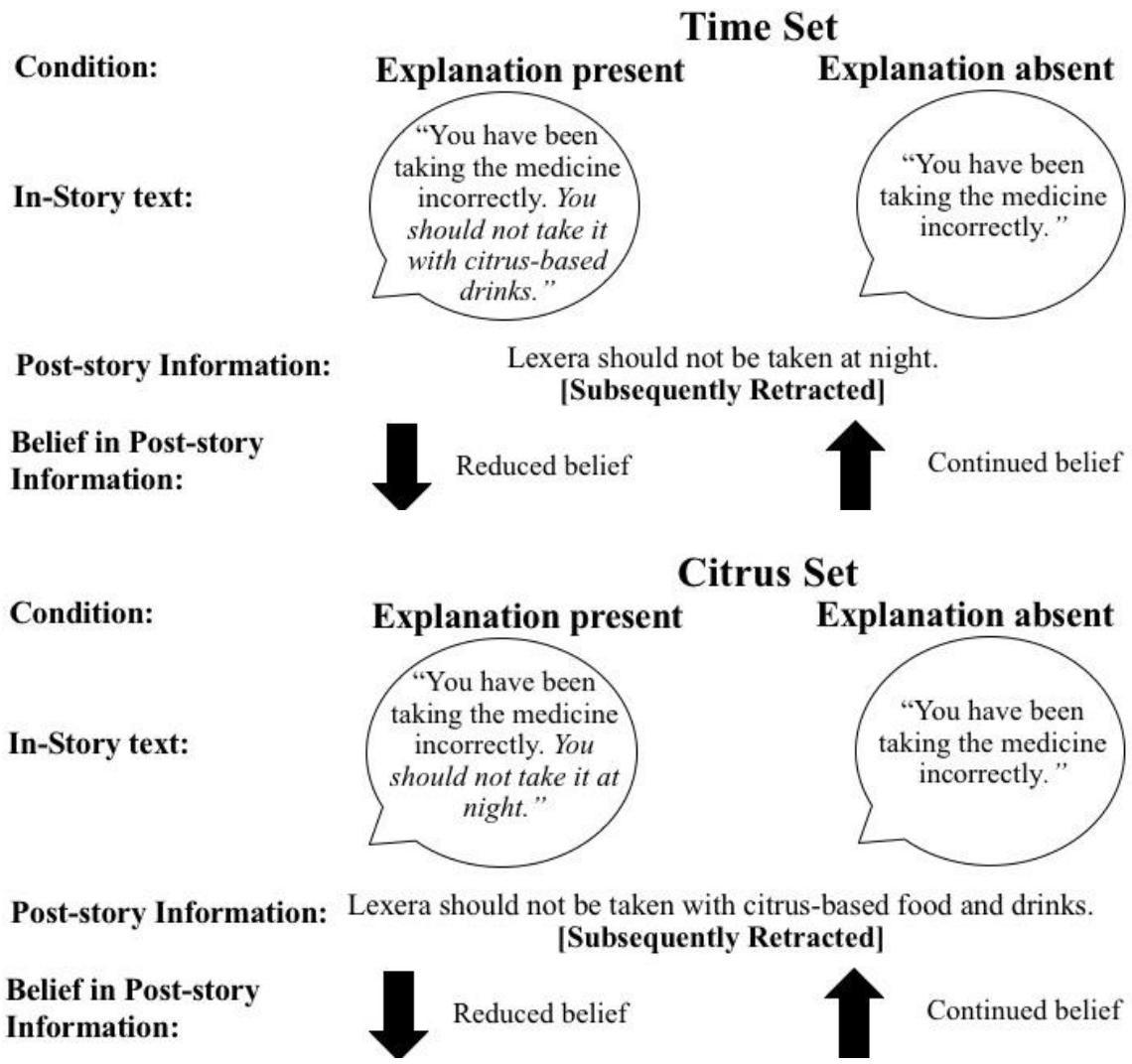
Participants. Undergraduate students at a university in the U.S. (N = 186 at time 1; N = 155 at time 2; 97 female, 58 male; M_{age} = 20.68) agreed to participate in a two-part study described as focusing on how consumers form opinions about health-related products.

Design and Materials. Two sets of testimonials were created, adapted from Simons and Green (2013; see web appendix). In both, the character describes the onset of a disease, initial diagnosis and treatment, including the key details of taking the prescribed medicine: (1) at night and (2) with a glass of lemonade. The drug (a fictional product called "Lexera" was used to control for potential prior knowledge about the drug) does not work for the character and he returns to the doctor. The key manipulation is whether the doctor does (or does not) provide an explanation for the drug's ineffectiveness in the story text.

In the first set of testimonials, the doctor either provides a time-based explanation for the ineffectiveness of the medication (explanation-present condition: "He said I should start taking it in the morning because the hormones released during sleep block Lexera's absorption") or does not provide an explanation (explanation-absent condition: the sentence omitted). Then, participants were presented with a separate block of factual information about Lexera which, along with decoy information about the drug, stated that citrus-based foods and drinks interfere with the absorption of Lexera. In the explanation-absent condition, which did not feature an in-story explanation for the ineffectiveness of the medicine, a reader can thus make an inference using this information to explain the story event (i.e., the medication was consumed with lemonade, a citrus-based drink; the drug did not work for the character because of the drug's interaction with citrus). In the explanation-present condition, which did feature an explanation for the ineffectiveness (i.e., wrong time of ingestion), the reader is less likely to use the post-story information to make an inference about the drug's ineffectiveness. Because we expected participants in the explanation-absent condition to make inferences based on the post-story information, we also expected that a retraction of this information would be less effective than in the explanation-present condition, where the information was less likely to be integrated into the story model. We collectively refer to this set of manipulations as the citrus set, because participants in both conditions received citrus-related post-story information (see Figure 2).

The second set of testimonials was a conceptual replication of the first set, reversing the cause stated in the story and the information presented after the story: We collectively refer to this set of manipulations as the time set, because participants in both conditions viewed post-story information about the timing of consumption. We note that the conceptual predictions for both the citrus and time sets are the same, but the dependent variable examined to test the predictions varies across the two sets. We pretested the manipulations to verify that the post-story information does enhance story comprehension in the explanation-absent relative to the explanation-present condition; see web appendix for more information.

Figure 2. Study 1 manipulations and predictions.



Procedure. Participants were assigned to one of four conditions in a 2 (story causality: explanation absent, explanation present) × 2 (post-story information: citrus, time) between-subjects design. Participants were told they would read a discussion board post about consumer health experiences. Participants read the stimuli describing a consumer's experience with Lexera, a pharmaceutical product. After reading the testimonial, participants were presented with a separate set of information about Lexera, as described previously. Immediately following this page, participants were presented with the statement: "On the previous page you were presented with a bulleted list of facts about Lexera. Please ignore these facts; these facts are actually false." After this, participants completed several measures of their opinions about the story (to be consistent with the study instructions). These measures included the short form of a narrative transportation scale (Appel, Gnambs, Richter, & Green, 2015). This measure was included to ensure story quality and test for an impact of overall engagement with the story (van Laer et al., 2014). Analyses controlling for transportation did not change the patterns of significance in this or subsequent studies, nor did transportation exert significant effects on the dependent measures. The discussion section briefly considers the implications of these results for narrative persuasion.

Participants entered their names and email addresses and agreed to participate in the second part of the study (in order to receive credit), which was completed at least 24 but no more than 48 hours later. During the second session, participants answered the focal dependent measures. First, participants answered a general open-ended question designed to measure story-related inferences using the retracted information: "In the first part of the study, you read a

story about a consumer's experience. Please describe what happened in the story in a few sentences." Participants then evaluated whether they believed a set of statements were true or false (indicating post-story information acceptance); these statements included some decoy statements ("More men are affected by genetic diseases than women"; "Lexera is a drug made to treat apertremia disease"), followed by the focal dependent measures: "Citrus-based foods and drinks interfere with the absorption of Lexera"; and "Hormones released during sleep interfere with the absorption of Lexera."

Following these questions, participants were presented with a more specific open-ended measure (again, to measure story-related inferences): "In the story you read, the consumer had some initial problems with his medication: it did not work, at first. Why?" Finally, participants were presented with a retraction awareness measure: "After you read the story, you were presented with additional statements about Lexera. Was this information true or false?"

Results

Retraction Awareness. Most participants correctly recalled that the information was false, or retracted (120/155). Analyses retaining all individuals are reported below (Whether participants correctly recalled the retraction did not moderate the results in this, and subsequent, studies: that is, when retraction awareness was entered as a variable in the analyses below, relevant interactions were non-significant).

Story-Related Inference. Two coders blind to hypotheses categorized responses to the open-ended questions to assess whether participants mentioned the within-story or post-story information as a cause of the character's complications (interrater reliability: Cohen's K = .92, $t = 14.55$, $p < .001$; discrepancies were resolved through discussion). Responses were scored in terms of whether they mentioned citrus ("he was not taking it correctly because he drank it with lemonade"), timing ("he was having problems because he took the medication at night"), or both, as a causal factor. We combined responses to the general question (asking participants to describe what happened to the consumer) and the specific question (about the cause of the consumer's difficulties); thus, we obtained a citrus inference score and a time inference score, both ranging from 0 to 2.

We conducted a 2 (story causality: explanation absent, explanation present) × 2 (post-story information: citrus, time) ANOVA on the citrus inference score. This analysis yielded an interaction, $F(1,151) = 64.98$, $p < .001$, $\eta_p^2 = .30$, and planned contrasts supported the prediction that participants who viewed the post-story citrus information in the explanation-absent condition ($M = 1.02$, $SD = 0.74$) referenced it more than participants in the explanation-present condition ($M = 0.23$, $SD = 0.43$; $F(1,151) = 30.51$, $p < .001$, $\eta_p^2 = .17$).

We next conducted a 2 (story causality: explanation absent, explanation present) × 2 (post-story information: citrus, time) ANOVA on the time inference score, and again found a significant interaction, $F(1,151) = 96.96$, $p < .001$, $\eta_p^2 = .39$. Participants who received the post-story time information in the explanation-absent condition were significantly more likely to cite it as the cause of the character's problems ($M = 0.89$, $SD = 0.65$) than participants in the explanation-present condition ($M = 0.02$, $SD = 0.16$; $F(1,151) = 56.06$, $p < .001$, $\eta_p^2 = .22$).

Finally, we examined the percentage of participants in the explanation-present condition that referenced both potential causes; two participants mentioned both the within and post-story information in their open-ended responses, which is a rate that does not differ significantly from zero, $t(82) = 1.42$, $p = .159$.

Post-Story Information Acceptance: Belief in Citrus Claim. We conducted logistic regression analyses on the focal beliefs (due to the dichotomous nature of the dependent measures), first regressing story causality (explanation absent, explanation present), post-story information (citrus, time), and their interaction, on responses to the belief statement "Citrus based foods and drinks interfere with the absorption of Lexera." Here, the critical test is whether participants who viewed the post-story citrus claim in the explanation-absent condition agreed with it more than participants in the explanation-present condition.

Though not critical to our hypotheses, we also expected participants in the time set conditions to vary in their citrus claim beliefs, for different reasons: participants in the time set, explanation-present condition received the citrus information in the story; belief in the citrus information would thus simply be evidence of a narrative persuasion effect. Participants in the time set, explanation-absent condition never received the citrus information, so should not believe it at a rate that differs from chance.

There was a main effect of story causality: the explanation-absent condition enhanced the likelihood of belief acceptance (β = -.92, *SE* = .46, Wald $\chi^2(1) = 3.91$, $p = .048$). This effect was qualified by an interaction with post-story information (β = 1.67, SE = .67, Wald $\chi^2(1) = 6.20$, $p = .013$). As predicted, participants who received the citrus post-story information in the explanation-absent condition were more likely to believe the citrus claim (68%; even though they were immediately told the claim was false), than participants who viewed the same claim after reading an explanation-present narrative (46%; Z = 2.00, $p = .045$; results in the time set conditions also conformed to expectations—see web appendix).

Post-Story Information Acceptance: Belief in Time Claim. We repeated the previous analysis on responses to the belief statement, "Hormones released during sleep interfere with the absorption of Lexera." Both main effects were significant (story causality: β = 1.50, *SE* = .47, Wald $\chi^2(1) = 9.81$, $p = .002$; post-story information: β = 1.65, *SE* = .51, Wald $\chi^2(1) = 10.34$, $p = .001$), as was the interaction term (β = -2.67, *SE* = .69, Wald $\chi^2(1) = 15.09$, $p < .001$). As expected, participants in the explanation-absent condition were more likely to accept the post-story misinformation as true, despite its retraction (71%), than participants who viewed the same information in the explanation-present condition (44%; Z = 2.41, $p = .016$; results from the citrus set condition are included in the web appendix).

Decoy Beliefs. We tested for effects of our manipulation on decoy beliefs to rule out a general response bias. We conducted a logistic regression to examine whether the causal structure of the narrative (story causality: explanation absent, explanation present), post-story information (citrus, time), and their interaction, predicted the true-false response to each decoy measure. The analyses revealed no differences by condition or their interaction (βs < .51, Wald χ^2s < .88, *p*s > .350).

Discussion

Study 1 illustrated that individuals viewing identical misinformation (information initially presented as true, followed by a retraction) show differences in their continued belief in this information and its use to make inferences about the story depending on whether a relevant story in memory does or does not present a causal explanation for the associated event. This supports H1: when the story provided a clear explanation for the event, the misinformation was less likely to exert continued influence on story-related reasoning and beliefs. We note that, unlike in the explanation-present condition of this study, previous research that embedded two event causes in a story found substantial continued influence of a retracted second cause (Ecker et al., 2015). We argue that the current results corroborate the notion that corrected misinformation exerts continued influence only if it is integrated into a mental model, either because the misinformation is presented within a coherent story (as in Ecker et al., 2015), or because information presented post-story serves to fill the gap in an existing but incomplete model (as in the present study's explanation-absent condition). The present study provides evidence that misinformation need not be processed online (embedded in a story) in order to exert continued influence; the mere ability to readily link it to a story in memory is critical. Moreover, we demonstrate that the continued influence effect does not produce a truth bias (i.e., the manipulation did not influence belief in decoy statements).

Responses to the open-ended questions provided additional evidence that participants who read a story lacking an explanation for the character's complications integrated the post-story information into their mental model: despite its retraction, they were more likely to mention the post-story information when recalling the story and in their explanations about why the character in the narrative experienced difficulties with the medication.

Study 2: The Continued Influence of Causal versus Non-Causal Information

The main goal of Study 2 was to conceptually replicate the findings of Study 1 by holding the story content constant and manipulating the causal relatedness of the post-story information. We expected that causally-related information would be more readily integrated into the reader's mental model of the story than less causally (but still topically) related information, and as a result, yield greater belief following a retraction.

A secondary aim of Study 2 was to investigate whether misinformation can have downstream consequences on behavior. A great deal of past work has demonstrated the continued influence effect in the domain of reasoning and beliefs, which theoretically should extend to consumer behavior. However, few studies have investigated effects on behavioral intentions or actual behavior. MacFarlane, Hurlstone, and Ecker (2018) found that misleading information from incomplete contingency tables (e.g., information that a majority of consumers experienced a health benefit from a product, with no information on how many consumers experienced the same benefit after a placebo treatment)

increased participants' willingness to pay for the product despite a refutation. Nyhan, Reifler, Richey, and Freed (2014), however, investigated the impact of messages aiming to reduce vaccination misconceptions and found that effects on beliefs do not translate to equivalent effects on behavioral intentions. Here, we expected that (retracted) misinformation conveying a positive benefit about a product should enhance selection intention when it causally (relative to topically) relates to a story event.

Method

Participants. A total of 75 university students participated for course credit (40 female, 35 male, $M_{age} = 22.11$).

Procedure. Participants completed the study on a computer in a behavioral lab. Participants read a short story adapted from a book of real-life short stories (Duke, 2013; see web appendix) describing a woman's experience playing in a poker tournament. One of the key sentences (not original to the story) reads: "I reach down and pull out my bottle of kombucha, which I like to drink at poker matches. I take a long deep swig from the bottle. And I have clarity of mind. I fold." This sentence allows for the possible causal inference that the character's mental clarity was due to the kombucha but this relationship is not explicitly stated.

Immediately after reading the story, participants were presented with text blocks of information about the story ("Did you know…?"). Several claims were presented, along with the target statement (the only claim about kombucha included in the set): "Kombucha contains usnic acid [which clarifies thinking and decision-making processes / promotes muscular function]." The information stating that usnic acid clarifies thinking and decision-making processes allowed readers to infer why the poker player experienced mental clarity during the poker match; this is the *causal* condition. The information stating that usnic acid promotes muscular function was topically related (because it is a fact about kombucha) but did not provide causal insight into the story; this is the *topical* condition. After exposure to the target information, the participants read the retraction statement. Participants then completed the short form of the narrative transportation scale, as in Study 1. Participants were told that they had completed the first part of the study and were then presented with a distractor task.

Participants completed the key dependent measures approximately 30 minutes later. Participants first answered four multiple-choice questions measuring recall of factual details mentioned in the poker story (e.g., "What was the player's gender? [male/female]") that we did not expect to differ by condition. We scored and averaged these responses into a story-memory score (see web appendix for all questions). Participants then completed three open-ended story-related questions designed to measure reliance on post-story information in participants' inferential reasoning about the event (e.g., "Why did the character win the match?"). The responses to these open-ended measures were categorized by a coder blind to experimental condition to indicate references to the post-story misinformation in participants' story-related inferences (e.g., "The character was able to win because the kombucha helped clear her mind"). We averaged the scores together to form a *story-related inferences* composite, with higher scores denoting more frequent misinformation references.

Participants also completed two open-ended non-story-related questions designed to measure *post-story information acceptance* (e.g., "What do you remember about the drink kombucha?"). Responses were scored to denote belief that kombucha enhances focus (*mental focus belief*); to denote belief that kombucha enhances muscle function (*muscular function belief*); and to denote belief that kombucha contains usnic acid (*usnic acid belief*). Finally, participants indicated agreement with closed-ended belief statements: "Kombucha contains usnic acid" and "Usnic acid can help focus during intense moments." To streamline analyses, we averaged the closed-ended and open-ended questions to create three composite scores representing mental focus belief, muscular function belief, and usnic acid belief (We recoded the 7-point Likert scale to match the scale of the open-ended responses; that is, from 0 to 1). Analyses with separate measures are included in the web appendix. Finally, participants completed a retraction awareness measure.

At the end of the series of measures, participants were instructed to write down a number that appeared on the screen, and to give it to the research assistant upon exit in order to receive credit for participation. The number denoted the experimental condition. After revealing this number to the research assistant, participants were told that they could select from a series of beverages to thank them for their participation. Participants were presented with a range of options (an energy drink, soda, water, juice, and kombucha). The research assistant made a note of the option selected. Four participants did not select any option. Our focal analysis was whether kombucha selection differed by condition.

Results

Retraction Awareness. Six participants incorrectly recalled the post-story information as true.

Story-Memory Measure. Nearly all (70/75) participants correctly answered the fact questions, as expected; the rate did not differ by condition (see Table 1).

Table 1. Dependent Measures, Study 2.

Dependent Variable		Topical (n = 37)	Causal (n = 38)	Test Statistic	p	η_p^2
Fact Recall Score						
	M	.99	.97	$t(73) = 0.90$	.371	.01
	SD	.06	.12			
Story-related Inferences						
	M	.35	.61	$t(73) = 4.26$	<.001	.20
	SD	.30	.23			
Post-story Information Acceptance						
Usnic Acid Belief						
	M	.41	.62	$t(73) = 2.94$	<.001	.11
	SD	.29	.32			
Mental Focus Belief						
	M	.36	.72	$t(73) = 5.94$	<.001	.32
	SD	.27	.26			
Muscular Function Belief						
	M	.15	.00	$t(73) = 3.53$	<.001	.15
	SD	.26	.00			
Kombucha Selection Frequency		9/37	16/38	$Z = 1.63$	.05	

Story-Related Inferences. We first examined whether the inferences made about kombucha's role in the story differed between the causal and topical conditions. This analysis provides information about the extent to which readers used retracted information to explain the story, relative to the inferences about kombucha's effects that would naturally be made in response to the story. A one-way ANOVA on the story-related inference composite revealed a difference such that participants in the causal condition were more likely to make an inference using the retracted information (i.e., refer to kombucha helping the character focus and win the poker game) than participants in the topical condition; see Table 1.

Post-Story Information Acceptance. The retracted misinformation claim had two components: one basic claim that all participants received (kombucha contains usnic acid) and one claim that related specifically to the story character's behavior and that varied by condition (the usnic acid in kombucha improves muscle function versus mental focus). We first examined the former; as indicated in Table 1, participants in the causal condition were more likely to believe that kombucha contains usnic acid than participants in the topical condition.

We then tested whether acceptance of the misinformation that specifically related to the story character's behavior differed by condition; the critical prediction was that participants would be more likely to endorse retracted misinformation if it facilitated comprehension of the story's cause-and-effect structure. That is, we expected stronger endorsement of the mental focus notion in the causal condition than the muscular function notion in the topical condition. This was confirmed by the data: Participants' acceptance of the provided but retracted post-story

misinformation was greater in the causal condition (mental focus; $M = 0.72$, $SD = 0.26$) than in the topical condition (muscular function; $M = 0.15$, $SD = 0.26$), $t = 9.58$, $p < .001$. As shown in Table 1, we also found that the mental-focus misinformation was accepted more if it was explicitly provided after the story (i.e., in the causal condition) than if it was only implicitly hinted at in the story (i.e., in the topical condition), even though the latter still produced a non-trivial level of endorsement (Given this non-trivial endorsement of merely hinted-at misinformation, another way to test our critical hypothesis is to contrast difference scores, namely endorsement of mental focus in causal – topical conditions versus endorsement of muscular function in topical – causal conditions. This analysis also confirmed our hypothesis, $t = 6.99$, $p < .001$ (mental focus: $M_{diff} = .36$; muscular function: $M_{diff} = .15$). Likewise, the muscular-function misinformation—which did not explain a key event in the story—was only endorsed if it was explicitly provided; the rate of endorsement in the topical condition was relatively low but significantly greater than zero, $t(36) = 3.48$, $p < .001$.

Product Selection. Sixteen participants selected the target product in the causal condition, whereas nine selected it in the topical condition. A one-tailed *Z*-test of proportions showed that this difference was marginally significant.

Discussion

Study 2 showed that participants used misinformation to explain a relationship presented in the story, despite it being retracted, with more references to mental focus in the causal condition than the topical condition (where the misinformation was hinted at but not explicitly provided). Participants in the topical condition endorsed the post-story information they were exposed to at a rate that was objectively lower than participants in the causal condition, but at a rate that was greater than zero. Some participants in the topical condition did continue to believe the misinformation to which they were exposed, suggesting it was attended to, encoded, and recalled, at least to some degree.

Participants were also more likely to directly endorse retracted misinformation when it could be causally connected to a story in memory, relative to information that was only topically related, supporting H1. This finding reduces the plausibility of an alternative explanation of the Study 1 results, related to differences in processing evoked by the different story structures, as the story presented in Study 2 was constant across conditions. Naturally, this does not rule out the possibility that people engage in more active information seeking after processing ambiguous content; yet, because condition differences emerged in Study 2 even though the story was ambiguous in both conditions, this may be a necessary but not a sufficient prerequisite for strong continued influence to arise.

Finally, participants in the causal condition were marginally more likely to select the product featured in the story, despite the fact that all participants received the same story mentioning kombucha in a positive manner. This provides some support that the continued influence of misinformation can impact behavior as well. However, evidence was weak given the marginal effect, and thus further examination of this process is an area for future research: the selection in the causal information condition may be due to the desirability of the attribute presented in the causal condition (mental focus versus muscular function), or an indirect effect of the misinformation enhancing the salience of kombucha's perceived benefit implied in the story. Nonetheless, the current study is suggestive in terms of a potential impact of misinformation on decisions relating to product consumption.

Study 3: Story Ending Valence

Study 3 tested whether the continued influence of misinformation will be reduced when a story in memory ends in a negative (relative to positive) manner (hypothesis 2a and 2b). This prediction was based on the notion that readers of a negative ending should be more likely to prioritize their need for an accurate mental model over their need for a complete model. We also obtained additional measures to provide insight into how participants who have already received an explanation for a character's experience in the story process additional information presented after the story. We have proposed that post-story misinformation is easier to retract in this case because it is not integrated into the mental model of the story. This explanation implies that the information is encoded into memory but subsequently disregarded. An alternative account might suggest that the post-story information is never attended to in the first place—as the individual already has a complete mental model, any extra information may be ignored. We thus collected page-view time measures to examine attention to the post-story information.

Method

Participants. We recruited U.S.-based participants via MTurk (N = 198, M_{age} = 39.18; 108 female, 87 male, 3 other; min. 95% HIT approval rating). The study was described as focusing on how consumers form opinions about health-related products.

Materials. Participants read the story from Study 1, in which a character takes medication at night with a glass of lemonade, but it does not alleviate his symptoms. In the explanation-present (explanation-absent) condition, the doctor provides (does not provide) an explanation for the medication's ineffectiveness (In this study, we used the story set where incorrect time of ingestion is given as the cause within the story). As in Study 1, this constituted the story causality manipulation. The story's ending either details that the character changes what he is doing and gets better (positive-ending condition; identical to Study 1) or that the character is unable to receive effective treatment (because the medication's window of effectiveness has elapsed) and does not get better (negative-ending condition). Participants then viewed information about the drug that resembles the drug facts section on pharmaceutical product labels. The information included the key citrus-related claim mentioned in Study 1 (the drug should not be taken with citrus-based foods and drinks because they interfere with absorption). Participants were then told that the information provided was incorrect (as the manufacturer accidentally included information relevant for a different drug) and were asked to disregard the information. Finally, participants completed the dependent measures. All materials are provided in the web appendix.

Procedure. The study was introduced as a collaborative effort with a "well-known pharmaceutical product manufacturer" to enhance realism. Participants were required to first answer questions designed to screen out bots and inattentive participants in order to gain access to the survey, as suggested by Goodman and Paolacci (2017).

The story was presented one paragraph at a time. Participants read through the story in a self-paced manner which allowed us to measure the amount of time participants spent viewing each part of the story. We were particularly interested in the amount of time spent on the page featuring the factual information about Lexera, as well as time spent viewing the retraction page. We examined the distribution of these measures, which indicated the presence of outliers; these were winsorized by setting all data above the 95% percentile at the 95% percentile level.

Immediately following the story, participants completed story opinion measures as in prior studies, as well as a manipulation check measuring the effectiveness of the story ending manipulation ("The consumer in the story experienced a negative outcome" answered on a 7-point scale from "strongly disagree" to "strongly agree"). Participants were told that they had completed the first part of the study and were then presented with a 20-min distractor task.

Participants were then asked to complete follow-up questions regarding the first part of the study. They were first presented with an open-ended measure to examine story-related inferences ("The consumer experienced complications with a drug. Why?"). Responses were scored by an assistant blind to hypotheses on two dimensions: whether the post-story citrus information was cited as a causal factor and/or whether the explanation given in the story (i.e., the time factor, relevant only for the explanation-present condition) was used.

Participants then judged a series of six belief statements on 7-point scales from "definitely false" to "definitely true (e.g., "Citrus-based foods and drinks interfere with the absorption of Lexera") which were combined into a composite representing post-story information acceptance, α = .84. We also assessed agreement with a peripheral belief statement, "Lexera causes drowsiness," a statement that was included in the post-story information presented to participants, but was not causally related to the story. We next obtained three measures of story-memory (e.g., "The consumer in the story was diagnosed with apertremia syndrome"; also using 7-point scales from "definitely false" to "definitely true"), which we combined into a composite (α = .55; analysis with the items individually yielded empirically identical results). We did not expect recall of story-related factual information to vary across conditions. Finally, we collected a retraction-awareness measure.

Results

Manipulation Check and Retraction Awareness. We conducted a 2 (story causality: explanation absent, explanation present) × 2 (story valence: positive, negative) ANOVA on the manipulation check measure. Participants were more likely to agree that the consumer experienced a negative outcome in the story featuring a negative ending (M = 5.92,

SD = 1.11) relative to the positive ending (*M* = 3.64, *SD* = 2.02), $F(1,194) = 98.53$, $p < .001$, $\eta_p^2 = .34$; no other effects were significant (*F*s < 1). A minority of the participants stated that the retracted misinformation was true (25/198 participants); this did not differ by condition, and analyses below retain all participants.

Story-Related Inferences. We first examined whether the participants' inferences to explain the story with post-story misinformation differed by condition. We conducted a logistic regression, with story causality, story valence, and their interaction predicting reliance on the post-story citrus misinformation. A main effect of story causality emerged, β = -1.45, *SE* = .62, Wald $\chi^2(1) = 5.50$, $p = .019$, indicating that participants referred to misinformation more in the explanation-absent than the explanation-present condition. A main effect of story valence also emerged, β = 1.01, *SE* = .45, Wald $\chi^2(1) = 5.16$, $p = .023$, indicating that participants were more likely to refer to the misinformation when the story ending was positive. The interaction was not significant, β = -.88, *SE* = .86, Wald $\chi^2(1) = 1.06$, $p = .300$.

As the information regarding time of ingestion was provided only in the explanation-present condition, we next examined how this affected participants' explanations of the character's complications in that condition. Participants mentioned the within-story information more often than not (60/104), and mostly as the sole explanation; only 6 out of the 60 participants cited both the within-story and the post-story information (this rate was still significantly greater than zero, $Z = 2.49$, $p = .012$). See Table 2.

Table 2. Story-related Inferences in Open-Ended Responses by Condition, Study 3

Condition	Post-story Information (Citrus)	Within-story information (Time)	Both within story and post-story related information
Explanation Absent, Negative Ending (*n* = 48)	12	0	0
Explanation Absent, Positive Ending (*n* = 46)	22	0	0
Explanation Present, Negative Ending (*n* = 55)	4	33	3
Explanation Present, Positive Ending (*n* = 49)	4	27	3

Post-Story Information Acceptance. We next conducted a 2 (story causality: explanation absent, explanation present) × 2 (story valence: positive, negative) ANOVA on the post-story information acceptance composite. This analysis yielded a main effect of story causality, $F(1,194) = 33.17$, $p < .001$, $\eta_p^2 = .15$, indicating that target beliefs were more likely to be endorsed in the explanation-absent condition. A main effect of story ending also emerged, $F(1,194) = 4.53$, $p = .034$, $\eta_p^2 = .02$, indicating that target beliefs were more likely to be endorsed in the positive condition. These main effects were qualified by an interaction, $F(1,194) = 5.69$, $p = .018$, $\eta_p^2 = .03$; participants in the explanation-absent condition who viewed a positive ending were significantly more likely than participants who viewed a negative ending to endorse the target beliefs about Lexera, $F(1,194) = 9.72$, $p < .001$, $\eta_p^2 = .05$. Information acceptance did not differ as a function of story valence for participants in the explanation-present condition, $F(1,194) = .03$, $p = .85$). See Table 3.

Table 3. Information Acceptance and Story-Memory by Condition, Study 3

	Explanation Absent		Explanation Present	
	Positive Ending	Negative Ending	Positive Ending	Negative Ending
Post-Story Information Acceptance				
M	5.36^{abc}	4.43^{ade}	3.68^{bd}	3.74^{ce}
SD	1.10	1.37	1.64	1.56
Peripheral Information Acceptance				
M	5.15	4.75	4.35	4.38
SD	1.73	1.98	2.22	2.35
Story-Memory Composite				
M	6.25	6.38	6.30	6.33
SD	1.16	1.02	1.09	1.18

Note. Pairs of means which share the same superscript (e.g., a-a, b-b, etc.) differ significantly, $p < .05$.

Peripheral Information Acceptance. An analogous 2 × 2 ANOVA on endorsement of the peripheral information (included in the retracted information but not related to the story) yielded a marginally significant main effect of story causality, $F(1,194) = 3.85$, $p = .051$, $\eta_p^2 = .02$, indicating that participants in the explanation-absent conditions tended to agree more with the statement that Lexera causes drowsiness.

Story-Memory Score. A 2 × 2 ANOVA on the story-memory composite revealed that there were no differences as a function of condition, Fs < 1.

Page-View Durations. We conducted a 2 × 2 ANOVA examining the amount of time spent viewing the post-story information. No effects were significant (Fs < 1). An analogous analysis on page-view time for the retraction, however, yielded a main effect of story causality, $F(1,194) = 5.74$, $p = .017$, $\eta_p^2 = .03$; participants in the explanation-absent condition spent more time viewing the retraction ($M = 10.88$ s, $SD = 7.66$) than participants in the explanation-present condition ($M = 8.56$ s, $SD = 6.44$). A main effect of story valence also emerged, $F(1,194) = 13.38$, $p < .001$, $\eta_p^2 = .065$; participants who read the negative ending spent more time examining the retraction ($M = 11.31$ s, $SD = 7.66$) than participants who read the positive ending ($M = 7.87$ s, $SD = 6.02$). The interaction term was not significant, $F(1, 194) = 1.83$, $p = .178$.

Discussion

Study 3 again provided support for H1: We found continued reliance on post-story misinformation, which was influenced by whether participants already had a causal within-story explanation for the occurrences. In other words, when the story already provided a clear explanation for the event, the misinformation was less likely to exert continued influence.

Study 3 also provided support for H2a and H2b: The influence of retracted post-story misinformation was reduced when the story ending was negative, which may have boosted participants' motivation to maintain an accurate event model. Participants in the negative ending condition did not differ in the time they spent examining the post-story information, which suggests that the differences in continued influence are unlikely due to differences in attention devoted to encoding the post-story information. However, participants in the negative ending condition did spend more time viewing the retraction, presumably because of their desire for a correct model over a complete model (see Pennycook & Rand, 2018) and the associated information integration required.

The results from this study also provide some insight into how participants who received a causal explanation in the story (explanation-present condition) processed the post-story information. Our page-view time measures indicated that there were no differences between explanation-present and explanation-absent conditions in the amount of overall time spent attending to the post-story information page (Of course, this measure is not sufficiently granular to rule out selective attention to the post-story misinformation by condition, despite equal overall time spent on the page.

However, participants in the explanation-present condition spent less time on the retraction page, suggesting that they attended to the post-story information but found it easy to dismiss, presumably because they already had a complete mental event model.

In Study 1, there were no differences in participants' endorsement of decoy beliefs (that is, beliefs unrelated to the story) by condition. However, in the current study, participants in the explanation-absent condition were marginally more likely to endorse a peripheral claim (that is, a claim related to the story but in a non-causal way) embedded in the post-story information than participants in the explanation-present condition. It is possible that participants in the explanation-absent condition scrutinized the post-story information more in search of a causal explanation for the story events, potentially leading to stronger encoding of that information. Collectively, this evidence suggests that participants in explanation-absent versus explanation-present conditions did not differ in the amount of attention devoted to the post-story information, but may have differed somewhat in terms of how deeply they encoded the information. It is also possible that the post-story information was encoded by participants in the explanation-present conditions but not retrievable from memory because it was not integrated into their mental model; future research remains to examine whether a general retrieval impairment might be able to explain the responses of participants in the explanation-present conditions.

Over half of the participants in the explanation-present condition cited within-story information (i.e., incorrect time of ingestion) as an explanation for the character's experienced complications, suggesting that they possessed a complete mental model of the story event. Few participants mentioned both explanations (i.e., within-story and post-story information). Thus, while it appears possible for participants with existing and complete mental event models to integrate additional post-story information into their model, this seems to be a rare occasion.

General Discussion

Across three studies, the current work demonstrated that information presented after a story that is subsequently revealed to be false can continue to influence readers' reasoning and beliefs. This effect is pronounced when the information enhances comprehension of a story in memory (Study 1) and can fill a causal "gap" in an individual's mental model of a story (i.e., the effect is less likely to occur with non-causally related information; Study 2). The influence of post-story misinformation can extend to behavior (Study 2; though results were marginal). However, the continued influence of misinformation is attenuated when the story ends in a negative manner (Study 3). This presumably occurs because a negative ending boosts accuracy motivation, thus reversing the typically observed preference for a complete (but incorrect) mental event model over a correct (but incomplete) model.

Theoretical Contribution

Continued Influence Effect. Past work on the continued influence effect (CIE) of misinformation has repeatedly demonstrated that it occurs for information embedded in a narrative, such as a news story or report (Johnson & Seifert, 1994; van Oostendorp & Bonebakker, 1998). This effect has been shown to occur for causal information that is encountered in the context of processing a single story. As Seifert (2014, p. 45) noted about the seminal Johnson and Seifert (1994) study, the target misinformation "had to be *part of the story line"* in order to influence participants' answers about an event cause. The present study refutes the notion that the target information must be processed as part of the story, and demonstrates that the CIE can result from misinformation received after a story is encoded, with the magnitude of the effect influenced by the story representation in memory; specifically, whether the associated mental event model and its cause-effect structure is complete. The current work indicates that readers will apply the mental effort needed to incorporate additional information encoded after the online processing of a story into an existing mental event model if the new information retroactively facilitates story comprehension. This suggests that the scope of the continued influence effect may be broader than initially explored: the separation of the target information from the story did not render the information less resistant to retraction.

The present work demonstrates the importance of contextual factors in creating the continued influence effect. Identical information viewed in two distinct processing contexts (whether a relevant mental model is complete) can differ in its robustness to retraction, which shows that the objective *content* of it is less influential than the role the information plays. Specifically, information that serves an explanatory function (fills a "gap" in a model) will be more likely to produce a continued influence effect. We extend past work (which has focused on information that must be removed from a mental model, potentially creating a "gap") by showing that consumers' reluctance to correct misinformation applies to that which is retrospectively added to a mental model.

The current work showed that influence of misinformation is reduced when the story ends in a negative manner, which arguably boosts the motivation to maintain an accurate mental model. This finding is consistent with past work showing that the continued influence effect varies based on individual differences related to effortful processing, such as verbal intelligence and working memory capacity (Brydges et al., 2018; De keersmaecker & Roets, 2017). Likewise, efforts to increase skepticism before the processing of a message reduces the effect (Ecker et al., 2010). The current work suggests that structural elements of the story (such as ending valence) can accomplish a similar outcome.

Narrative Persuasion. The current work also has implications for research on narrative persuasion (Escalas, 2007; Green & Brock, 2000; van Laer et al., 2014). Past work in this literature stream has examined the consequences of online story processing on story-related beliefs. The current work shows that the scope of narrative processing extends beyond the online processing of the narrative itself; that is, factual information can be integrated into a story model. People often try to impose story structure on unrelated information (Thorndyke, 1977), and the current work shows that this effort spans both the time horizon (linking new information to a story in memory) and format (linking factual information to a story).

Much research in the consumer literature has focused on narrative transportation as a key determinant of persuasive effects (van Laer et al., 2014). Controlling for transportation in the current work did not change results, which suggests that stories influence beliefs through additional mechanisms: the current work suggests that another key reason stories are persuasive is due to the ease with which information is structured into a causal chain, and the resistance of this chain to alteration once it has been formed. People appear to easily integrate information into their memory representation of a story, enhancing resistance to counter-persuasion.

Narrative persuasion researchers may thus benefit from considering additional mechanisms through which the truth value of a story is determined. The current work is consistent with work suggesting that truth is judged through intuitive (vs. reasoning) processes. Schwarz, Newman, and Leach (2016), for example, suggested one means by which people evaluate claims is to rely on subjective feelings of truth, or "truthiness," which can emerge from a sense that information "hangs together" (such as when encountered information seems to explain a story in memory). The current work provides more insight into specific ways non-probative (or, non-truth related) information or stimuli can enhance the perceived truth of a statement. That is, perceived truth of information may be determined less by the objective content of the information and more by its coherence with the mentally-generated whole.

Applied Implications

The current work has consequences for transformative consumer research. Organizations concerned with consumer welfare can benefit from the knowledge that it is easier to correct misinformation embedded in stories with negative endings (or potential negative consumer implications), such as when the original story describes a product harming a consumer. Stories that end in a benign manner—such as those that describe a recovery, a triumph, or other benefit—pose more of a challenge for regulatory agents seeking to correct the public's belief. Further, retraction efforts appear to be particularly challenging in contexts where misinformation is related to the cause-effect structure of the story. For example, people may believe in the healing power of a miracle supplement if a celebrity credits it for their high-profile recovery, even if scientific evidence publicly discredits this claim. Simply providing people with the correct "facts" does not mean that people will update their mental model to reflect them. In these cases, it may be necessary to provide a detailed refutation that includes a causal component; for example, if a drug complication is not, in fact, caused by an interaction with a certain type of food, it may be necessary to not only explain that the assumption is false and why, but also provide some explanation for why the assumption was initially held in the first place (see Ecker et al., 2019; Paynter et al., 2019). Regulatory agencies may enact policies surrounding retraction efforts that leverage this insight: companies issuing a retraction may be required to explicitly articulate an alternative causal explanation (if available) as well as the reasons behind the initial, false assumption, rather than a mere negation of prior information.

It is also worth considering the role of the media in creating and perpetuating misinformation. The current work suggests that media professionals should think through how they describe causes of events in their stories. While a journalist may be attempting to uphold professional standards of accuracy by leaving the cause of a story ambiguous when they cannot verify it, consumers may "fill in the holes" in an inaccurate way. Such ambiguities can be exploited by other persuasion professionals that offer a plausible explanation for an event. The current results might inform media-literacy interventions to raise awareness that misinformation campaigns may take advantage of events that have no good explanation. For example, a high-profile plane crash or celebrity diagnosis with a disease may create a

vulnerability arising from a widely shared story that can be exploited by disinformants. Relatedly, media-literacy interventions might educate consumers about the influence of product placement within entertainment media; if a product played a causal role in a story (such as a character's miraculous recovery from illness by taking a proprietary supplement), simply reminding consumers that the product may not actually have this benefit is unlikely to be effective in reducing belief.

The current work suggests that practitioners seeking to *enhance* belief in target information should consider how it can be presented to fit with related stories in memory. As demonstrated in the current work, audiences expose to marketing communications featuring stories will build a mental model that serves as a structure into which subsequent information (specifically, *causal* information) can be readily integrated. An advertisement may illustrate a consumer using a product to resolve a certain problem, with subsequently presented information explaining *why* or *how* that product was effective. The additional information should then be readily integrated into the story model (and consequently, remembered and accepted). In general, the key factual information should be presented as an explanation for an effect: it is arguably the experience of understanding the story that makes the target information memorable and resistant to counter-persuasion. The current work suggests that communication efforts can be effective even when elements are presented at distinct time points; for example, an initial social media post about a consumer's experience can be followed up with a more fact-based post providing the target information (which is causally linked to the consumer's experience) at a later time.

Limitations and Future Directions

The current research examined the continued influence of misinformation presented immediately following a narrative. One limitation of the current work is that it did not empirically demonstrate comprehension as the explanation for why post-story causal misinformation results in higher retention and impact than non-causal misinformation; future work may provide additional empirical evidence. Future work also remains to explore the scope and limits of information integration: can information presented after a substantial temporal lag be integrated into a story in memory, given a relevant cue? Relatedly, what contextual elements enhance the likelihood that consumers will integrate presented information into existing real-world stories? For example, native advertisements placed in news sites are designed to blend into the embedding context and may be confused for and initially processed as news (rendering their correction more difficult).

Research can also be done to bridge the literatures on narrative persuasion (focused on the effects of narrative transportation) and integration of misinformation into a mental model. For example, research on narrative transportation suggests that one reason stories are persuasive is because the story experience feels like real experience; people mentally simulate the experience of the story world in a vivid manner (van Laer et al., 2014). Vividness of (and transportation into) a story may moderate the persistence of misinformation, such that misinformation embedded in a vivid story is more difficult to correct.

While the current work examined how misinformation that can be embedded in a story resists retraction, future work could also examine the efficacy of story-based attempts to correct misinformation. Such efforts may vary in efficacy as a function of their ability to transport readers. Given the shared importance of mental models to the literatures on narrative persuasion and the persistence of misinformation, processes examined in the context of narrative persuasion may aid understanding of the continued influence of retracted information, as well as avenues to successfully correcting it.

Research examining how variation in the way misinformation is presented influences the domain of behavior and choice would be of theoretical and practical importance. The current work examined the influence of retracted information on behavior when it was topically versus causally related to the story. The marginal effect we found might reflect a direct impact of corrected misinformation on behavior, but (assuming it is a real effect) it may have also arisen as an indirect effect of the misinformation enhancing the salience of kombucha's perceived benefit implied in the story. To investigate this, a future study may examine the continued influence effect on behavior that does not have any connection to the story. This could be accomplished by a design comparing behavior in conditions in which (1) no information is presented, (2) just the false claim is presented, (3) just the story (which hints at but does not explicitly provide misinformation) is presented, or (4) both story and claim are presented. In general, future research is needed to systematically investigate the potential impact of retracted misinformation on actual behavior.

Questions remain about how people who already possess a complete mental model of a story respond to retraction efforts that falsify information subsequently encountered. The current work showed that people do not necessarily pay less attention to the (subsequently) retracted information. However, attention was examined at the level of aggregate time spent on encoding the post-story information. More nuanced, biometric measures such as eye tracking could confirm this finding, and provide insight into whether attention to the post-story information does vary depending on relationship to the story.

Finally, future work should examine how other aspects of a reader's background knowledge moderate the demonstrated effects. In the real world, fundamental preexisting attitudes and beliefs can affect the processing and retention of misinformation. Lewandowsky and colleagues (2012) introduced the term "worldview backfire effect" to describe the phenomenon in which retractions of worldview-congruent misinformation can potentially backfire and ironically strengthen the very misconception they are meant to correct (but see Ecker & Ang, 2019; Wood & Porter, 2019). For example, consumers who believe in the efficacy of naturopathic remedies may be *more* likely to believe in their effectiveness following a related retraction. Relatedly, particularly authoritative retractions may be ineffective because of reactance (Wolf & Montgomery, 1977); consumers who are told that they must disregard information about a political candidate when making decisions about voting may actually be more likely to factor the discredited information into their choices. Overall, there are many likely fruitful avenues future research can take to untangle and correct the effect of misinformation on beliefs.

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