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Epistemic language in news headlines affects readers' perceptions of objectivity

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Abstract

Information from the news undoubtedly shapes what we believe is true, but we argue the language it employs also influences whether we think an assertion has a ground truth at all. Six studies examined how epistemic language in particular influences adults' inferences of objectivity and truth. When headlines about novel topics (Studies 1a-b) or climate change (Studies 3a-b) presented information as belief (e.g., "Tortoise breeders **believe** tortoises are becoming more popular pets"), adults rated that information as less objective and less likely to be true compared to information presented as knowledge (e.g., "Tortoise breeders **know** [...]"). Epistemic language even influenced participants' objectivity judgments when it had no influence on their truth judgments (Studies 2a-b). Overall, these results show the way epistemic language frames information affects what we perceive as true and, more so, whether we believe an objective truth exists in the first place.

Keywords: belief formation; objectivity; epistemic language; semantics; pragmatics

Introduction

Media consumption is central to how we form, maintain, and spread beliefs in the modern world. Perhaps as important as the content itself is how the content is presented. For example, consider "Scientists **know** climate change is severe" and "Scientists **believe** climate change is severe." While "know" presents its complement (that climate change is severe) as a *fact* by presupposing it is true, "believe" does not. Further, by not presupposing truth, "believe" leaves open the possibility that its complement does not have an objective truth value in the first place, communicating that the severity of climate change could be a subjective matter of *opinion* (see Figure 1).

Epistemic verbs like "know", "understand", "think", and "believe" that express a subject's attitude toward a proposition are pervasive in widely-consumed sources of media (Wortham & Locher, 1996; Barthel et al., 2020). Yet, despite their prevalence, we know little about how their usage shapes people's beliefs, not only in terms of whether they think a given piece of information is true, but also whether they think the broader issue has an objective truth value in the first place. Understanding both types of influence is increasingly important given the rising polarization and politicization of high-stakes social and scientific issues in US news media, such as climate change, vaccine safety, and election integrity, where information from experts is regularly mediated through epistemic language (Hart, 2011; Bolsen & Shapiro, 2018; Wilson,
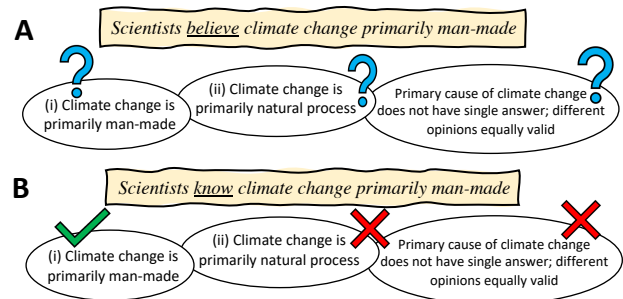
Figure 1: Illustration of how epistemic verbs license different inferences about truth and objectivity. In **A**, *believe* does not assert the truth of (i) or (ii), meaning it is possibile there is no single ground truth to begin with. In **B**, *know* asserts the truth of (i) and implies there is a single ground-truth to the primary cause of climate change.

Parker & Feinberg, 2020). Furthermore, understanding how language affects our perceptions of objectivity may uncover some of the mechanisms underlying the rise of "post-truth" politics and the dissemination of "alternative facts" (Suiter, 2016; Barrera et al., 2020).

Prior work in communications has documented journalists' use of epistemic language, hedges, and other expressions of (un)certainty (Rom & Reich, 2020; Ekström, Ramsälv & Westlund, 2021). However, these studies do not explore downstream influences of language on *audience* beliefs, and additionally focus on breaking news, for which the use of epistemic language is justified by the limited and changing information available. For instance, in coverage of an ongoing fire, journalists may specify that their reports are "according to eyewitnesses". In contrast, we examine how epistemic language shapes audiences' inferences in contexts where journalists are not obviously constrained in the commitment they can express. Specifically, we examine judgments about news headlines on non-developing stories.

Headlines are well-suited for controlled manipulation of epistemic language, and are influential sources of information, making up the bulk of consumers' information diet (Rosenstiel et al., 2014); in fact, many consumers rarely read beyond headlines at all (Bode, Vraga & Troller-Renfree, 2017). Moreover, prior work has found bias in the epistemic verbs used in articles from right- and left-leaning outlets, underscoring the potential ramifications of such choices (Luo,

Card & Jurafsky, 2020). However, it is unknown to what extent these journalistic choices ultimately influence audiences' beliefs.

Epistemic language, truth, and objectivity

Prior research has documented how epistemic verbs do and do not presuppose truth (Kiparsky & Kiparsky, 2014; Karttunen, 1971; Saurí & Pustejovsky, 2009) and shown how these semantic properties enable us to make inferences about the world (Falmagne, Gonsalves & Bennett-Lau, 1994; Scoville & Gordon, 1980) and speakers' beliefs in conversation (de Marneffe & Manning, 2012; Prabhakaran et al., 2015). In particular, *factive* verbs like "know" and "understand" are distinct from *non-factive* verbs like "believe" and "think" due to their entailment patterns: "Mike **knows** it's raining outside" entails that it is indeed raining outside; conversely, "Mike **thinks** it's raining outside" does not necessarily entail that it is raining outside, even if it suggests it might be. At the same time, these entailments are sensitive to contextual factors like listeners' prior beliefs (Degen & Tonhauser, 2022).

Nonetheless, prior work has not assessed the influence of epistemic verbs on listeners' beliefs in a news media context. Does using a factive verb in a headline lead audiences to perceive its content as more true? We might expect factive verbs to be associated with higher levels of belief, as their semantics predict. On the other hand, audiences may shift to non-linguistic cues to form their beliefs in response to headlines, such as their priors about the headline's content.

Nor has previous work, to the best of our knowledge, considered the influence of epistemic verbs on listeners' inferences about objectivity. We argue that truth and objectivity, though related, are conceptually distinct. For example, regardless of whether or not a listener agrees that it is raining outside, they likely consider the issue to have an objective, ground truth: either it is raining, or it is not. Conversely, a listener could disagree with a speaker on a subjective issue, such as whether pie is better than cake, but still accept the speaker's assertion as valid from their own perspective.

Because factivity implies that a ground truth exists, we predict that factive verbs might also signal to listeners that their content is more *objective*. Conversely, non-factive verbs do not guarantee the existence of a ground truth and could communicate that their content is more *subjective*. For example, "most Americans *think* that climate change is man-made" could imply the truth of man-made climate change is not yet known, meaning the use of "know" is currently not licensed; or the source of climate change is a matter of opinion that has no ground truth in the first place, in which case "know" is never licensed. In contrast, factive verbs do not imply the same uncertainty; "most Americans know that climate change is man-made" implies that man-made climate change has a ground truth. Even if someone might disagree with whether or not climate change is actually man-made, it is an issue that licenses the use of "know", meaning it has an objective answer. Therefore, the use of non-factive verbs in media may lead readers to infer that an issue is at least par-

tially subjective while factive verbs enshrine objectivity.

Additionally, while the influence on truth can in principle be ameliorated with more evidence, the influence on objectivity is potentially more difficult to dispel. For example, if someone believes climate change is not an objective phenomenon but instead a matter of opinion whose truth depends on who you ask, they may subsequently view evidence supporting climate change as more subjective or biased. In the extreme, beliefs about subjective phenomena can become untethered from evidence and more closely associated with group membership (e.g., Bar Tal, 1993; Boyer, Aaldering & Lecheler, 2022) or identity (e.g., Kahan, 2015; 2017).

The Current Studies

To examine the influence of epistemic language on adults' beliefs about truth and objectivity, we presented adults with news headlines and manipulated the epistemic verbs present—factive, non-factive, or none (rendering the headline a generic statement). The generic served as a baseline so that we could examine how particular kinds of epistemic verbs as well as their presence in general impact participants' judgements. After viewing each headline, participants were asked to rate the degree to which they thought the content of the headline was true (truth rating) as well as whether the content was more of a matter of fact or opinion (objectivity rating). Across the studies, we manipulated whether truth and objectivity ratings were asked together (1a, 1b) or separately (2a, 2b, 3a, 3b) to examine how reasoning about truth and objectivity influenced each other. We also varied whether the headlines themselves were about relatively neutral topics that participants were unlikely to possess strong prior beliefs about (1a, 1b, 2a, 2b) or climate change (3a, 3b), a highly visible, polarizing topic. This allowed us to investigate both how epistemic language factors into belief formation as well as how it influences beliefs about known quantities.

Overall, we predicted that, across topics, participants would rate the content of headlines with factive verbs as more likely to be true and more objective compared to headlines with non-factive verbs. Additionally, because generics are often used to express facts, do not encode an individual's perspective, and are particularly generalizable (e.g., Cimpian, Brandone & Gelman, 2010), we predicted that the content of headlines expressed as a generic (i.e., with no epistemic verb) would be rated as the most likely to be true and objective.

Experiment 1

Our hypotheses and analysis plan for Studies 1a and 1b were preregistered at `https://aspredicted.org/BLR_QGY` and `https://aspredicted.org/KJY_3MQ`.

Participants: We recruited 152 participants (84 males, M.age = 27) for Study 1a and 251 participants (120 males, M.age = 27) for Study 1b from Prolific. They completed the study for payment. Six were excluded from 1a and 17 from 1b for failing any of two attention checks.

Items: We created 15 artificial headlines of the form: [group] [epistemic verb] [complement clause]; see our anonymized data repository for all headlines used. When no

epistemic verb was included, the headline only contained the complement clause. The content of the headlines were designed to be reasonably, but not undeniably, believable. The subject of the headline was always a group rather than an individual to mirror most real world headlines containing epistemic verbs and avoid preferences for or against a particular individual. Additionally, the group was always a relevant, but non-expert, party to the phenomena described in the headline.

Procedure: Participants clicked through a Qualtrics survey at their leisure. After giving consent, participants were told they were going to read headlines and answer some simple questions about them, and to not consult external sources. Next, they completed 15 trials plus an attention check trial. In Study 1a, 5 trials each had headlines containing "believe", "know", or no epistemic verb. In Study 1b, 3 trials each had headlines containing "believe", "think", "know", "understand", or no epistemic verb. The headline-verb combinations were counterbalanced and their order was randomized.

For each trial, participants saw a headline at the top of the page. Two rating questions appeared as sliders ranging from 0-100 underneath. The first rating question (truth rating) asked participants to rate how likely the complement clause in the headline was true (e.g., "how likely do you think it is that tortoises are becoming more popular pets"). A number was marked every 25 points and there were three anchor labels, from left to right, "very unlikely", "moderately likely", "very likely". The second rating question (objectivity rating) asked participants to rate whether there is an objective answer to the above question (100) or whether they thought it was more of a matter of opinion (0). The scale contained two anchors, from left to right, "definitely a matter of opinion" and "definitely a matter of fact". After completing all 15 trials, participants completed an additional attention check trial where they were asked to provide a particular rating. Afterwards, participants completed a short demographic questionnaire and were debriefed.

Results: We analyzed an effect of verb type using two mixed-effects linear regression models, one for each rating type (truth, objectivity); rating was predicted by epistemic verb type (factive, non-factive, none) as a fixed effect and random intercepts by participant and item. See Figure 2 for mean ratings by verb and rating type.

Participants rated headlines containing factive verbs as more likely to be true than headlines containing non-factive verbs, $t(2028) = 2.16$, $p = .031$ (1a), $t(3260) = 6.5$, $p < .001$ (1b). Headlines containing no epistemic verb were rated as most likely to be true overall, and were rated as significantly more likely to be true compared to headlines containing non-factive verbs, $t(2028) = 3.93$, $p < .001$ (1a), $t(3260) = 6.3$, $p < .001$ (1b).

Participants also rated headlines containing factive verbs as more likely to be objective matters of fact compared to headlines containing non-factive verbs, $t(2028) = 4.9$, $p < .001$ (1a), $t(3260) = 8.47$, $p < .001$ (1b). Headlines containing no

epistemic verb were rated as most objective overall, and were rated as significantly more objective compared to headlines containing non-factive verbs, $t(2028) = 10.33$, $p < .001$ (1a), $t(3260) = 11.03$, $p < .001$ (1b).

To summarize, headlines containing factive verbs led participants to view their contents as both more likely to be true and more objective compared to headlines containing non-factive verbs (see Figure 2).

Experiment 2

In Studies 1a and 1b, truth and objectivity were rated at the same time, so one rating may have influenced the other or created a more salient contrast. Thus, the next set of experiments replicated the previous results, but participants rated truth and objectivity between-subjects. Our predictions were the same as the previous set of experiments, pre-registered at `https://aspredicted.org/BK8_4NF` and `https://aspredicted.org/QKS_JYZ`.

Participants: We recruited 303 participants (146 males, M.age = 29) for Study 2a and 501 participants (237 males, M.age = 28) for Study 2b from Prolific. They completed the study for payment. 11 were excluded from 2a and 15 were excluded from 2b for failing an attention check trial.

Items: We used the same headlines from Studies 1a and 1b.

Procedure: The overall procedure was similar to Studies 1a and 1b. However, participants were assigned to either the truth or objectivity rating condition between-subjects. Additionally, participants received two example items beforehand where the rating scale was explained. Participants then completed 15 rating trials followed by an attention check trial. In Study 2a, 5 trials each had headlines containing "believe", "know", or no epistemic verb. In Study 2b, 3 trials each had headlines containing "believe", "think", "know", "understand", or no epistemic verb. The headline-verb combinations were counterbalanced and their order was randomized. In each trial, participants were first asked to read a headline by itself. On the following page, participants were again shown the headline with the rating question below.

In the truth rating condition, participants were asked if they thought the complement clause was true (e.g., "Do you think tortoises are becoming more popular pets?"). The rating scale was a 0-100 slider with 5 anchors, from left to right: "definitely not", "probably not", "neutral", "probably", "definitely". In the objectivity rating condition, participants were asked if they thought there was a single, correct answer to whether or not the complement clause is true, or multiple possible answers based on personal opinion, (e.g., "Do you think there is a single, correct answer (100) to whether or not tortoises are becoming more popular pets (a matter of objective fact), or do you think there are multiple possible answers based on personal opinion (0) (a matter of opinion)?"). The scale also had 5 anchors, from left to right: "entirely a matter of opinion", "mostly a matter of opinion", "neutral", "mostly a matter of fact", "entirely a matter of fact".
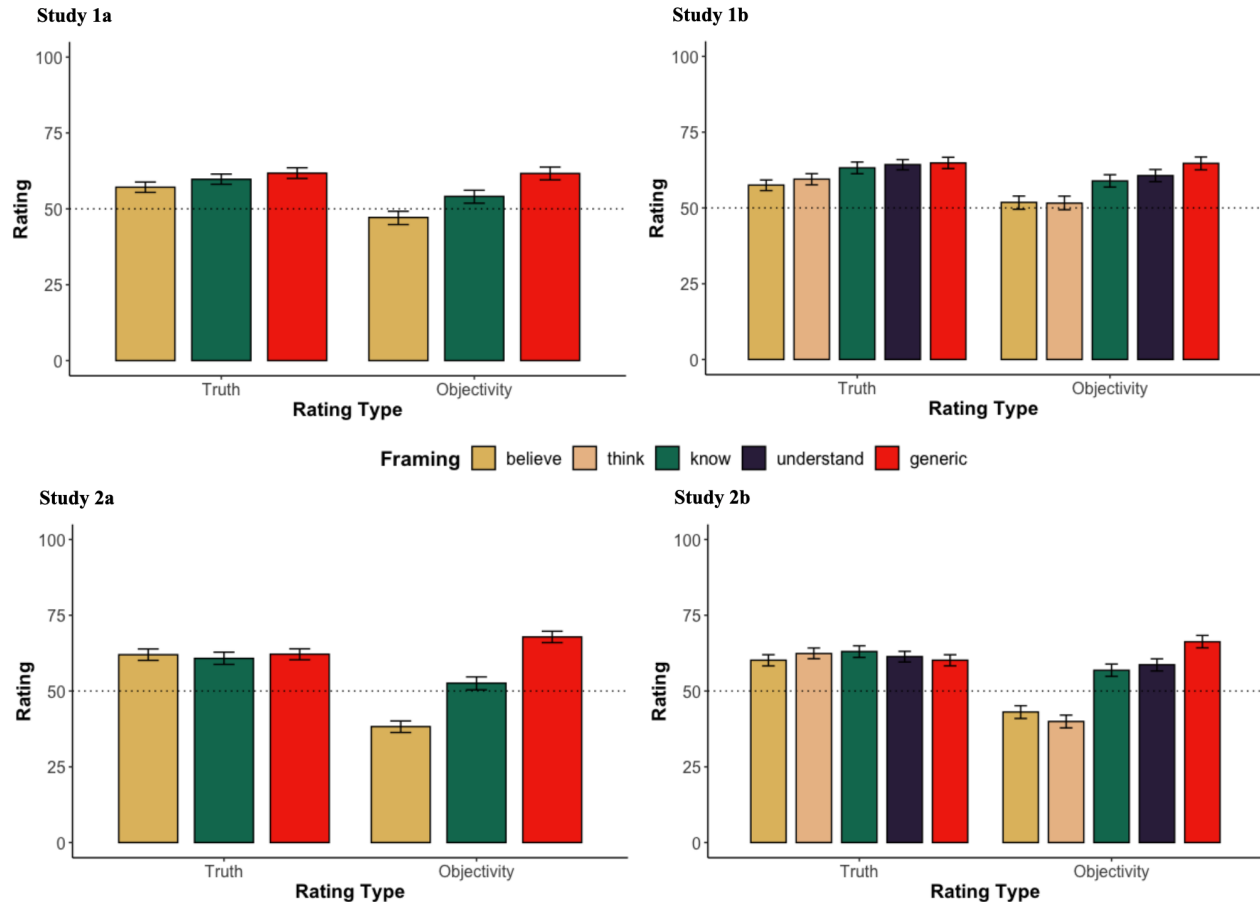
Figure 2: Average rating by rating type and framing for Studies 1a-b & 2a-b; error bars indicate 95% bootstrapped confidence intervals. In Studies 1a-b, participants rated the contents of novel headlines containing non-factive verbs ("believe", "think") as less likely to be true and objective compared to headlines containing factive verbs ("know", "understand") or no epistemic verb (generic). In Studies 2a-b, participants continued to rate novel headlines containing non-factive verbs ("believe", "think") as less objective, but epistemic verbs had little influence over participants' truth judgments.

Results: We used the same analysis plan as Studies 1a and 1b. See Figure 2 for mean ratings by verb and rating type. Unlike the previous studies, participants did not rate headlines with factive verbs as more likely to be true than headlines with non-factive verbs, $t(1987) = -1.28$, $p = .2$ (2a), $t(3402) = .93$, $p = .35$ (2b). Headlines with no epistemic verb were also not rated as significantly more likely to be true compared to headlines with non-factive verbs, $t(1987) = .09$, $p = .93$ (2a), $t(3402) = -1.3$, $p = .18$ (2b).

In contrast to their truth ratings, epistemic verbs continued to exert a strong effect on participants' objectivity ratings. Participants rated headlines containing factive verbs as more likely to be objective matters of fact compared to headlines containing non-factive verbs, $t(2070) = 10.9$, $p < .001$ (2a), $t(3369) = 15.72$, $p < .001$ (2b). Headlines containing no epistemic verb were rated as most objective overall, and were rated as significantly more objective compared to headlines containing non-factive verbs, $t(2070) = 22$, $p < .001$ (2a), $t(3369) = 20$, $p < .001$ (2b).

In summary, epistemic verbs in headlines had little effect on whether readers view their content as more true, but non-factive verbs did cause readers to view their contents as more subjective (see Figure 2).

Experiment 3

The prior two sets of experiments used synthetic headlines about relatively neutral topics, so their results speak to the way epistemic verbs shape adults' views on issues for which they have weak prior beliefs. However, many headlines come into contact with consumers' beliefs, values, and political attitudes. Therefore, the final set of studies examines the impact of epistemic verbs on a highly visible, politically contentious issue: climate change. We used the factive verb "understand" and the non-factive verb "think" because these were the most common and felicitous epistemic verbs among climate change headlines. We also used the verb "say" because it was the single most common verb used in climate change reporting and its influence was unclear. We preregistered our predictions and analyses at `https://aspredicted.org/X9V_V3S` and `https://aspredicted.org/1Y9_JLR`.

Participants: We recruited 405 participants (207 males, M.age = 27) for Study 3a and 401 (217 males, M.age = 29)
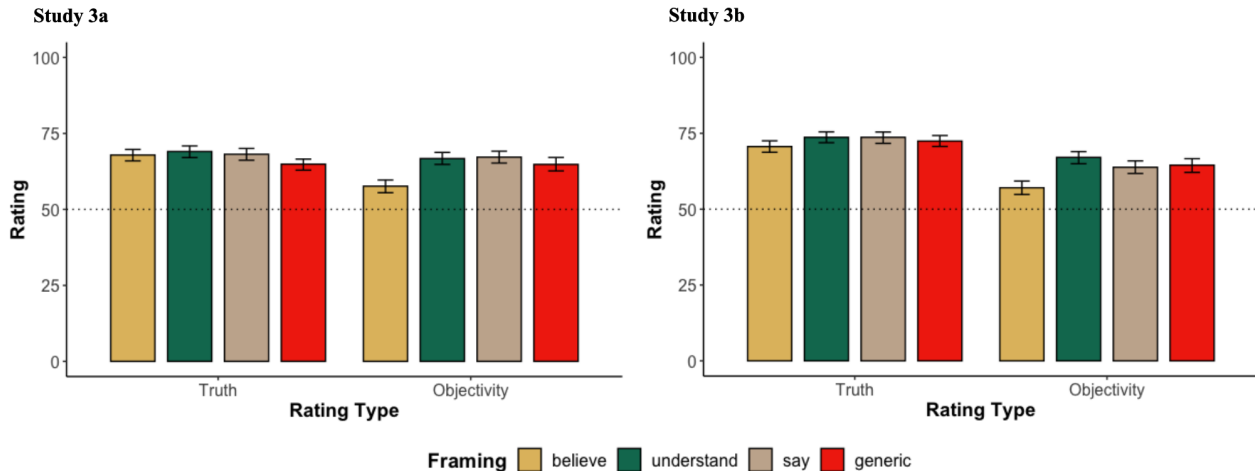
Figure 3: Average rating by rating type and framing for Studies 3a & 3b; error bars indicate 95% bootstrapped confidence intervals. Participants rated the contents of climate change headlines containing "believe" as less objective compared to when headlines contained "understand", no epistemic verb (generic), or "say"—the most common verb used in climate change headlines. However, epistemic verbs had little to no influence over participants' truth judgments. Study 3a examined headlines about specific climate change phenomena while Study 3b examined headlines about climate change in general.

participants for Study 3b from Prolific. They completed the study for payment. Seventeen were excluded from 3a and 12 were excluded from 3b for failing an attention check.

Items: See anonymized data repo for a list of all headlines used. We assembled a dataset of real-world headlines about climate change and related phenomena (e.g., carbon emissions, fossil fuels) by retrieving articles from a variety of left- and right-leaning media outlets using the MediaCloud API (Roberts et al., 2021) and relevant keyword stems (e.g., "climate", "global", "carbon"). From manual inspection, we found many headlines from right-leaning outlets made misleading or false statements about climate change. To avoid exposing participants to misinformation, we excluded headlines from these sources.

After removing duplicate headlines, we applied a rule-based NLP algorithm to find headlines with the structure [group] [epistemic verb] [complement clause], where the epistemic verb was not negated, part of a question, or embedded within a conditional or relative clause. We opted to further subset to headlines that used "say" since it was the most common verb and does not select for any particular semantic content of its complement clause. We next performed a series of manual deletions to remove (1) references to dates and events beyond the past year, to avoid outdated headlines; (2) named entities (e.g., "Harvard scientists"), with the exception of those that are crucial to understanding climate change headlines (e.g., geographic entities, UN, EPA), to avoid unforeseen item effects; (3) overtly biased or politicizing words (e.g., "alarmist", "liberal"). In cases where the deletions rendered the headline difficult to interpret, we removed the headline from our sample entirely. Finally, we performed a series of edits on the cleaned sample to ensure the consistency of headline syntax and grammaticality across items.

Procedure: The procedure was identical to 2a and 2b, except participants read 15 headlines about specific climate

change phenomena (3a) or climate change itself (3b). Additionally, headlines contained either "believe", "understand", "say", or no epistemic verb. Participants viewed headlines containing 3 or 4 of each verb. The headline-verb combinations were counterbalanced and their order was randomized.

Results: We used the same analysis plan as the previous studies. See Figure 3 for mean ratings by verb and rating type.

Participants' pattern of truth ratings were somewhat different for Studies 3a and 3b. Participants did not rate headlines about specific climate change phenomena (3a) that contained factive verbs as more likely to be true than headlines with non-factive verbs, $t(2678) = 1.22$, $p = .22$. Likewise, headlines with "say" were also not rated as more likely to be true compared to those with non-factive verbs, $t(2678) = .15$, $p = .88$. Interestingly, headlines with no epistemic verb were rated as the least likely to be true, significantly less than non-factive verbs, $t(2678) = -2.64$, $p = .008$. In contrast, participants rated headlines about climate change more generally (3b) that contained factive verbs as more likely to be true than headlines with non-factive verbs, $t(3071) = 3.09$, $p = .002$. Likewise, headlines containing "say" were also rated as more likely to be true compared to those with non-factive verbs, $t(3071) = 3.03$, $p = .002$, as were headlines containing no epistemic verb, $t(3071) = 2.15$, $p = .031$.

While participants' truth ratings diverged in Studies 3a and 3b, their objectivity ratings were nearly identical. Participants rated headlines containing factive verbs as more likely to be objective matters of fact compared to headlines containing non-factive verbs, $t(2734) = 6.77$, $p < .001$ (3a), $t(2689) = 7.8$, $p < .001$ (3b). This was also the case for headlines containing "say", $t(2734) = 7.05$, $p < .001$ (3a), $t(2689) = 5.32$, $p < .001$ (3b), and headlines containing no epistemic verb, $t(2734) = 5.32$, $p < .001$ (3a), $t(2689) = 5.87$, $p < .001$ (3b).

In short, while the influence of epistemic verbs on partici-

pants' truth judgments was weak and varied between studies, non-factive epistemic verbs reliably led readers to view headline content about climate change as more subjective (see Figure 3).

Discussion & Future work

Our work, to the best of our knowledge, is the first to investigate how epistemic language affects media consumers' inferences about objectivity. Overall, we found when headlines use factive verbs that presuppose truth (e.g., "know", "understand") compared to when the same headlines use non-factive verbs that do not presuppose truth (e.g., "believe", "think"), adults rated their contents as more likely to be objective matters of fact with a basis in ground-truth, as opposed to mere opinions, for which a variety of answers are equally valid. Though we expected epistemic verbs to influence perceptions of truth, factive verbs only caused adults to view contents as more true when rated alongside objectivity (Studies 1a-b), not when truth was rated independently (Studies 2a-b). This result provides strong evidence that non-factive verbs in headlines can "soften" media consumers' intuitions about the objectivity of reported phenomena.

Impressively, adults' intuitions about objectivity were influenced by a single epistemic verb appearing in a single headline. This effect was most pronounced for headlines about unfamiliar topics (Studies 1-2), though still apparent for headlines about climate change (Studies 3a-b). This suggests epistemic language can affect both how consumers form new beliefs and update existing ones. Further, a majority of consumers obtain at least some of their news via social media, where they scroll through many headlines at a time (Barthel et al., 2020). Thus, the influence of epistemic language could compound rapidly. Overall, epistemic language stands to impact the way we view topics both short and long term, though more work is needed to understand how long term media diets affect consumers' beliefs.

A number of factors we did not consider (e.g., audience political affiliation, trust in information source, and headline tone) could mediate or amplify the influence of epistemic language. Prior work has shown people are more likely to trust headlines from outlets aligning with their own political affiliation, though this effect is minor compared to the effect of headline content (Jakesch et al., 2018; Pennycook, Gordon & Rand, 2021). Prior research also suggests that people's judgments of objectivity are sensitive to their expertise on a topic (Rudin & Kaiser, 2021), so the presence of expert subjects in headline stimuli (e.g., "scientists") may have led participants with greater trust towards those experts to judge those headlines as more objective.

Nor do our studies resolve the relationship between adults' perceptions of truth and objectivity; rather, our goal was to show that objectivity is an independent concept worth probing. Given prior work on factive presupposition (e.g., Scoville & Gordon, 1980; Falmagne, Gonsalves & Bennett-Lau, 1994), one might expect epistemic verbs to primarily impact readers' intuitions about truth, only affecting their intuitions about objectivity secondarily. However, we found the oppo-

site pattern: epistemic verbs had the strongest effect on readers' intuitions about objectivity and only weakly influenced their judgements of truth. Though it may be tempting to attribute the weak effect on truth to general news skepticism, we found that participants' truth ratings routinely fell above 50, i.e., on average, they believed headlines to be somewhat true. Instead, we hypothesize that epistemic verbs may lead readers to make stronger pragmatic inferences about objectivity than truth, at least in a media context. After all, both factive and non-factive epistemic verbs imply that a speaker believes something is true. Conversely, while factive verbs almost always imply that a speaker believes an objective truth exists, non-factive verbs are less committal. In fact, we frequently use non-factive verbs to express opinions (e.g., "I think apple pie is the best"). Additional research is needed to determine the nature of the relationship between truth and objectivity, as well as how epistemic language might mediate them.

Interestingly, participants inferred the most objectivity from generic statements, suggesting the presence of an epistemic verb itself implies some level of subjectivity. Because epistemic verbs express inherently private attitudes, generics are perhaps the strongest way to state a fact. This coincides with a body of findings demonstrating that generics are perceived as particularly generalizable (Cimpian & Erickson, 2012; Gelman, Star & Flukes, 2002), require little evidence for acceptance (Cimpian, Brandone & Gelman, 2010), and serve as a powerful learning mechanism for children and adults (Cimpian & Markman, 2009; Cimpian & Markman, 2011; Moty & Rhodes, 2021). Our work contributes to this literature by demonstrating that generics can communicate that a statement is itself an objective matter of fact.

In Studies 3a & 3b, the verb "say" followed a similar pattern, suggesting its pragmatic properties, at least in a media context, may more closely align with factive verbs or generics compared to non-factive verbs. Because "say" is among the most common verbs used in headlines, this journalistic default can have wide reaching implications for how consumers view phenomena discussed in news media. However, we are not arguing that non-factive verbs should never be used to discuss matters of fact, or that communicating objectivity is always desirable. Instead, the use of epistemic language in headlines trades off with many other factors, including felicity, potential for controversy, and novelty. Nor is epistemic language the only contributing factor to whether readers perceive the content of a headline as objective or subjective. Therefore, headline writers should consider both the potential impact of epistemic language on readers' beliefs as well as how headlines might shape the way readers perceive issues as matters of fact or opinion more broadly.

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