



The effects of communicating uncertainty on public trust in facts and numbers

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Uncertainty is inherent to our knowledge about the state of the world yet often not communicated alongside scientific facts and numbers. In the “posttruth” era where facts are increasingly contested, a common assumption is that communicating uncertainty will reduce public trust. However, a lack of systematic research makes it difficult to evaluate such claims. We conducted five experiments—including one preregistered replication with a national sample and one field experiment on the *BBC News* website (total $n = 5,780$)—to examine whether communicating epistemic uncertainty about facts across different topics (e.g., global warming, immigration), formats (verbal vs. numeric), and magnitudes (high vs. low) influences public trust. Results show that whereas people do perceive greater uncertainty when it is communicated, we observed only a small decrease in trust in numbers and trustworthiness of the source, and mostly for verbal uncertainty communication. These results could help reassure all communicators of facts and science that they can be more open and transparent about the limits of human knowledge.

communication | uncertainty | trust | posttruth | contested

Our knowledge is inherently uncertain. The process by which we gather information about the state of the world is characterized by assumptions, limitations, extrapolations, and generalizations, which brings imprecisions and uncertainties to the facts, numbers, and scientific hypotheses that express our understanding of the world around us. However, despite the fact that scientists and other producers of knowledge are usually well-aware of the uncertainties around their findings, these are often not communicated clearly to the public and other key stakeholders (1). This lack of transparency could potentially compromise important decisions people make based on scientific or statistical evidence, from personal medical decisions to government policies.

Recent societal developments do not seem to encourage more openness about uncertainty: It has been suggested that we are living in a “posttruth” era in which facts, evidence, and experts are deeply mistrusted (2). Cross-national survey studies suggest that in many countries, trust in institutions and governments is in decline (3–5). Although the underlying causes of changes in trust are likely to be complex and varied, it has been suggested that one way to potentially repair and restore public trust in science, evidence, and official statistics is to be more open and transparent about scientific uncertainty (2). However, it is often assumed that communicating uncertainty transparently will invite criticism, can signal incompetence, or even decrease public trust in science (1, 6–8). In fact, as summarized by the National Academies of Sciences, Engineering, and Medicine report on science communication, “as a rule, people dislike uncertainty [...] people may attribute uncertainty to poor science [...] and] in some cases, communicating uncertainty can diminish perceived scientific authority” (ref. 7, pp. 27–28). For example, research by Johnson and Slovic (9) found that for some respondents, uncertainty “evoked doubt about agency trustworthiness” (p. 490), and that “despite

the general sense of honesty evoked [by uncertainty] ... this did not seem to offset concerns about the agency’s competence” (p. 491). In fact, partly for these reasons, Fischhoff (1) notes that scientists may be reluctant to discuss the uncertainties of their work. This hesitation spans across domains: For example, journalists find it difficult to communicate scientific uncertainty and regularly choose to ignore it altogether (10, 11). Physicians are reluctant to communicate uncertainty about evidence to patients (12), fearing that the complexity of uncertainty may overwhelm and confuse patients (13, 14). Osman et al. (15) even go as far as to argue explicitly that “the drive to increase transparency on uncertainty of the scientific process specifically does more harm than good” (p. 131).

At the same time, many organizations that produce and communicate evidence to the public, such as the European Food Safety Authority, have committed themselves to openness and transparency about their (scientific) work, which includes communicating uncertainties around evidence (16–19). These attempts have not gone without criticism and discussion about the potential impacts on public opinion (15, 20). What exactly do we know about the effects of communicating uncertainty around facts, numbers, and science to the public?

Significance

Does openly communicating uncertainty around facts and numbers necessarily undermine audiences’ trust in the facts, or the communicators? Despite concerns among scientists, experts, and journalists, this has not been studied extensively. In four experiments and one field experiment on the *BBC News* website, words and numerical ranges were used to communicate uncertainty in news article-like texts. The texts included contested topics such as climate change and immigration statistics. While people’s prior beliefs about topics influenced their trust in the facts, they did not influence how people responded to the uncertainty being communicated. Communicating uncertainty numerically only exerted a minor effect on trust. Knowing this should allow academics and science communicators to be more transparent about the limits of human knowledge.

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UK jobs market 'shows signs of slowing'

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The UK jobs market is showing signs of slowing, after a surprise drop in the number of people in work.

The unemployment rate unexpectedly rose to an estimated 3.9% (between 3.7%-4.1%) in the June-to-August period from 3.8%, after the number of people in work unexpectedly fell by 56,000, official figures showed.

The Office for National Statistics also said employment growth had "cooled noticeably".

But the unemployment rate is still close to its lowest level for 44 years.

[Click here to take part in a short study](#) about this article run by the University of

Fig. 6. Image of the BBC News article that was used in experiment 5 (numerical condition: including a numeric range). Reprinted with permission from BBC News.

control condition. An ANOVA showed a significant main effect of uncertainty communication on perceived uncertainty [$F_{(2, 1526)} = 4.67, P = 0.01; \eta^2 = 0.006$]. Participants who read the version of the news article with a numeric range around the unemployment rate figure perceived the figure to be more uncertain than people in the control condition ($M = 3.56$ vs. $3.31, M_{diff} = 0.25, 95\% \text{ CI } [0.06; 0.44], d = 0.19$). Participants who read the version of the news article with the verbal cue scored in between the numerical and control conditions, not significantly different from either ($M = 3.41, SD = 1.39$). This finding suggests that participants did seem to have noticed the uncertainty that was communicated.

Uncertainty communication, however, did not affect participants' trust in the number [$F_{(2, 1526)} = 1.20, P = 0.30$], nor trust in the source, in this case, the statisticians responsible for producing the figures [$F_{(2, 1525)} = 1.24, P = 0.29$]. These findings complement the results from our laboratory experiments, which showed that a verbal cue such as "estimated" did not seem to communicate uncertainty to people and did not affect their trust in numbers or the source (as found in experiments 3 and 4). In this field experiment, we again found communicating uncertainty as a numeric range did not affect people's trust in the source, and it also did not affect trust in the number.

In addition, the results showed no significant effects of uncertainty communication on affect [$F_{(2, 1519)} = 0.44, P = 0.65$], competence of the source [$F_{(2, 1525)} = 0.61, P = 0.54$], and

trustworthiness of the journalist [$F_{(2, 1526)} = 0.86, P = 0.42$]. Participants' judgments of the competence and trustworthiness of the statisticians were highly correlated ($r = 0.80, P < 0.001$), and on the high end of the scale ($M = 5.44, SD = 1.41$, and $M = 5.28, SD = 1.55$, respectively, out of seven); participants' rating of the trustworthiness of the journalist was slightly lower ($M = 4.61, SD = 1.54$). These results suggest that communicating uncertainty to the participants of this field study, did not affect their (already positive) views of the trustworthiness and competence of the people involved in producing and reporting unemployment figures.

Discussion

Centuries of human thinking about uncertainty among many leaders, journalists, scientists, and policymakers boil down to a simple and powerful intuition: "No one likes uncertainty" (1, 6, 7, 27). It is therefore often assumed that communicating uncertainty transparently will decrease public trust in science (1, 7). In this program of research, we set out to investigate whether such claims have any empirical basis. We did this by communicating epistemic uncertainty around basic facts and numbers and by systematically varying 1) the topic, 2) the magnitude of the uncertainty, and 3) the format and context through which uncertainty was communicated. We assessed the effects of uncertainty on relevant outcome measures, including cognition and trust.

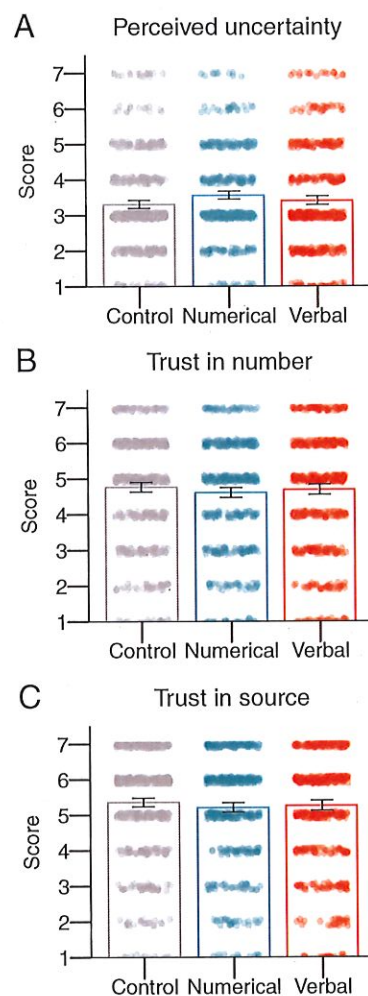


Fig. 7. The results of field experiment 5: Means per condition for perceived uncertainty (A), trust in numbers (B), and trust in the source (C). The error bars represent 95% CIs around the means, and the jitter represents the distribution of the underlying data.

P Overall, we found little evidence to suggest that communicating numerical uncertainty about measurable facts and numbers backfires or elicits psychological reactance. Across five high-powered studies and an internal metaanalysis, we show that people do recognize and perceive uncertainty when communicated around point estimates, both verbally and numerically (except when only words such as “estimated” or “about” are used to imply uncertainty). In addition, uncertainty did not seem to influence their affective reaction (*SI Appendix*), and although the provision of uncertainty in general did slightly decrease people’s trust in and perceived reliability of the numbers, this effect emerged for explicit verbal uncertainty in particular.

Our research offers an important bridge between producers of statistics, communicators, and their audiences. For example, statisticians or scientists could argue that because most numeric estimates are never completely certain, presenting uncertainty around the number offers more precise information and should therefore foster more trustworthiness, not less. However, if a general audience had not considered that there might be any uncertainty around a number in the first place (e.g., around unemployment), then from a purely normative point of view people’s reaction to uncertainty in our studies is not entirely appropriate: By providing clear variability around estimates, it is reasonable for people to adjust their level of trust in the numbers themselves. In a similar vein, one might argue that it is difficult for people to appraise the trustworthiness of a number without having access to the methodology through which the estimate is derived. However, from a social scientific standpoint, we recognize that people are frequently exposed to numbers in the news without necessarily having access to additional information, for example, about the quality of the underlying evidence (or indirect uncertainty). So how do people actually arrive at a judgment as to what numbers are reliable and trustworthy in the face of uncertainty? Although we did not set out explicitly to investigate the mechanism by which people adjust their judgments in response to uncertainty, an exploratory mediation analysis on the nationally representative sample (experiment 4) clearly suggests that the main effect of uncertainty communication (uncertainty vs. no uncertainty) on trustworthiness is fully mediated by people’s perception of the uncertainty (see *SI Appendix* for mediation analyses). In other words, this suggests that the more uncertain people perceive the numbers to be, the less reliable and trustworthy they find them. The current results help inform theoretical predictions about how people might respond to direct uncertainty about numbers, and we encourage future research to further investigate potential mechanisms as well as how people might respond to indirect uncertainty, such as additional information about the quality of the underlying evidence.

In sum, prior research has investigated whether the provision of uncertainty can help signal transparency and honesty on behalf of the communicator, or—in contrast—whether communicating uncertainty decreases trust and signals incompetence (9, 15, 17, 36). By and large, our findings illustrate that the provision of numerical uncertainty—in particular as a numeric range—does not substantially decrease trust in either the numbers or the source of the message. Verbal quantifiers of uncertainty, however, do seem to decrease both perceived reliability of the numbers as well as the perceived trustworthiness of the source. These findings were robust across topics (both contested and noncontested), mode of communication, and magnitude of uncertainty. More generally, the strong negative effects of verbal uncertainty appear consistent with prior findings that people are averse to more ambiguous statements (27, 43). As such, we hypothesize that the communication of numerical uncertainty may offer a degree of precision that reduces people’s tendency to view the admission of uncertainty as a sign of incompetence (1, 9, 36). On the other hand, across all studies, the communication of uncertainty never significantly increased perceived trust or

reliability either, which is an important finding in itself and warrants further research.

Accordingly, based on these results, we therefore recommend that the communication of uncertainty around basic facts and numbers in the media is best conveyed through numerical ranges with a point estimate. This format in particular did not seem to significantly influence (i.e., reduce) perceived trust and reliability in either the number or the source of uncertainty. In addition, we draw attention to the fact that using the word “estimate” or increasing the magnitude of the confidence interval did not seem to alter people’s perception of uncertainty, which points to the need to better contextualize the degree of uncertainty for people.

Last, it is notable that we find little evidence for the motivated cognition of uncertainty (35). For example, even around more contested topics, such as global warming and immigration, although main effects were observed for people’s prior attitude toward the issue, there was no significant interaction with the communication of uncertainty. At the very least, this suggests that motivated interpretations of uncertainty do not always occur. At the same time, we must acknowledge several limitations of our program of research.

First, we recognize that people are known to struggle with psychological uncertainty about the future (44, 45), perhaps more so than uncertainty about measurable facts and numbers, an area previously neglected, and thus the focus of the current work. The context of our research was also limited, culturally, to the United Kingdom, and more contested examples for this population (e.g., around the United Kingdom’s political exit from the European Union) may have elicited different results. Moreover, while we conceptually replicated our results across multiple studies and platforms—including a preregistered national sample—we did not investigate uncertainty around more emotionally charged topics in this study, such as uncertainty about personal health outcomes (e.g., cancer), nor manipulated contestedness as an experimental factor. Indeed, there may be other circumstances (not examined here) where a significant degree of uncertainty could elicit strong emotional reactions. Finally, we attempted to improve the ecological and external validity of our manipulations by engaging in a real-world experiment on the live *BBC News* website. Although findings corroborated what we observed in controlled laboratory settings, the BBC study necessarily relied on a somewhat skewed and self-selected sample. In addition, although we generally relied on large and diverse samples, and our main effects were sufficiently powered, we may not have had sufficient power to detect very small effects in all post hoc comparisons. Sensitivity analyses showed, however, that given the sample sizes of experiments 3 and 4 (and assuming $\alpha = 0.05$ and power of 0.80), we should have been able to detect small effects in these studies ($f = 0.101$, $d = 0.20$; and $f = 0.107$, $d = 0.21$, respectively). The smallest effects of interest reported in our paper are broadly beyond those thresholds (e.g., $d = 0.26$ to 0.72).

Nonetheless, even considering all of these boundary conditions, our results help inform and challenge strongly held—and often nonempirical—assumptions across domains about how the public will react to the communication of uncertainty about basic science, facts, and numbers (1, 7). A key challenge to maintaining public trust in science is for communicators to be honest and transparent about the limitations of our current state of knowledge. The high degree of consistency in our results, across topics, magnitudes of uncertainty, and communication formats suggest that people “can handle the truth.” However, if we want to effectively convey uncertainty about pressing issues, such as rising sea levels, the number of tigers left in India, the state of the economy, or how many people turn out to presidential elections; natural scientists, statisticians, and social scientists should work together to evaluate how to best present scientific uncertainty in an open and transparent manner. As such, our findings can provide valuable guidance to scientists, communicators, practitioners, and policymakers