nature climate change

Article

https://doi.org/10.1038/s41558-025-02472-1

Negative verbal probabilities undermine communication of climate science

Received: 27 September 2024

Accepted: 26 September 2025

Published online: 06 November 2025

Check for updates

Marie Juanchich[1] ✉, **Karl Halvor Teigen**[2], **Theodore G. Shepherd**[3] & **Miroslav Sirota**[1]

The Intergovernmental Panel on Climate Change (IPCC) recommends describing low-probability outcomes using negative verbal probability terms such as unlikely, rather than positive terms such as a small probability. However, we propose that this choice of probability terms might undermine public perception and understanding of climate science. Across eight preregistered experiments (N = 4,150), we find that participants perceive outcomes described with negative low probability terms as reflecting lower scientific consensus than probabilistically equivalent but positively framed terms. The effect persists after controlling for beliefs in climate change, familiarity with the IPCC and political orientation, although it weakens when the projected values exceeded participants' personal expectations. Participants also associate negative low-probability terms more strongly with extreme outcomes and judge them as less evidence-based than their positive counterparts. We recommend using positive verbal probabilities to communicate comparable levels of uncertainty without undermining perceptions of scientific consensus and evidence.

Climate misinformation[1,2] exploits the existence of uncertainty in climate science to sow doubt about how much scientists agree on climate science[3–7] and fuel climate change scepticism[8]. We complement that perspective by proposing that some forms of uncertainty communication can be a pernicious source of perceived disagreement, while others can foster more positive perceptions. We suggest that the negative verbal probabilities prescribed by the Intergovernmental Panel on Climate Change (IPCC) to communicate low-probability outcomes might inadvertently sow doubt about their evidential and consensual base.

The IPCC has standardized guidelines for communicating uncertainty. They prescribe the use of a set of probability terms (also called verbal probabilities) that are associated with numerical probability bands[9–11]. Like many international organizations (for example, the European Food Safety Agency (EFSA)[12], the North Atlantic Treaty Organization (NATO)[13] and the Financial Accounting Standards Board (FASB)[14]), the IPCC mandates the use of negative verbal expressions to characterize probabilities in the lower part of the scale (for example, 'unlikely' for <33%). We posit that this terminology is not ideal because of connotations implied by negative terms.

Verbal probabilities can have either a positive (affirming) or a negative (refuting) directionality. Positive verbal probabilities (for example, 'a chance') direct attention towards the possibility that an event might happen, whereas negative verbal probabilities (for example, 'unlikely') suggest that the event might not happen after all—even when they convey a similar probability[15,16]. One way to determine the directionality of a verbal probability is to ask for reasons in a sentence completion task. Statements including positive verbal probabilities, such as 'There is a chance of flood, because …', will normally be completed with supporting or enabling reasons for why a flood might occur (for example, 'it has rained a lot'). In contrast, a negative verbal probability, such as 'It is unlikely there will be a flood, because …' will be associated with disabling circumstances (for example, 'it has rained less than last year'). Negative directionality is often, but not exclusively, determined by the presence of a negation (as in 'unlikely'). For example, 'the likelihood is low' (suggested by the IPCC as an alternative to 'unlikely')[9] does not have a negation but would also elicit reasons against the event occurring.

It might seem sensible to use negative verbal probabilities for low-probability outcomes (<50%). However, in many domains,

[1]Department of Psychology, University of Essex, Colchester, UK. [2]Department of Psychology, University of Oslo, Oslo, Norway. [3]Department of Meteorology, University of Reading, Reading, UK. ✉e-mail: m.juanchich@essex.ac.uk

low-probability events are those for which preparedness is most needed[17]. A 20% chance might be 'small' technically and might seem inconsequential for mundane forecasts, but probabilities of this magnitude are not to be neglected for high-impact events[18]. Calling those events 'unlikely' might be misguided and undermine people's awareness that they could happen and obstruct decisions to prepare against these risks[16,19,20]. For example, in a computer game, people who were told that a landslide was 'unlikely' were less likely to evacuate the area than when the same landslide risk was described as having 'a small probability' of occurring[19]. The effect of directionality is akin to its better-known cousin, the attribute framing effect, where logically equivalent information leads to different decisions (for example, a 20% chance of success versus an 80% chance of failure)[21].

In addition to shaping attention and decisions, negative verbal probabilities might suggest a lack of scientific consensus. In everyday discourse, verbal probabilities with a negative directionality are typically used to voice disagreement with an over-confident speaker. For instance, a 30% probability was more often described negatively ('it is unlikely') when following a 50% estimate, but positively as 'a chance' when following a 10% estimate[22]. It is hence plausible that negative verbal probabilities would suggest contention, whereas positive ones, even those that indicate small chances, might emphasize that $P > 0$ and reflect scientific consensus. A corollary of this hypothesis about scientific consensus is that events described with negative verbal probabilities might not be perceived as being well grounded in scientific evidence, making them less trustworthy[23].

Negative directionality might indicate dissent (and poor data) because speakers often use negative verbal probabilities, such as 'unlikely', to describe outcomes that are so extreme that they are not supported by existing data[24,25]. For instance, when asked what is 'unlikely' in a distribution of quantitative outcomes (for example, sea-level rise and temperature rise), people tend to select extreme outcomes from beyond the range of possible values[24–26]—whereas they associate positive directionality with less extreme outcomes[24,27,28].

In eight experiments, we demonstrate that the IPCC negative uncertainty terminology inadvertently undermines the perception of scientific consensus, relative to a positive uncertainty terminology (preregistrations, materials, data and analytical scripts accessible at https://osf.io/ch4wf/; ref. 29).

Table 1 | Probability perception, outcome focus, agreement perception and out-of-range outcome selection rate for negative and positive climate projections

Verbal probabilities tested (*n*)	Mean probability (s.d.)	Reason against	Agrees versus disagrees	Out-of-range outcomes
Experiment 1 (*N*=301)				
Unlikely (74)	18.68 (13.25)	91%	15% versus 53%	61%
The likelihood is low (76)	17.70 (10.94)	86%	28% versus 35%	40%
There is a small probability (76)	15.07 (8.17)	43%	25% versus 26%	21%
There is a small possibility (75)	15.27 (9.26)	21%	34% versus 22%	23%
Experiment 2 (*N*=481)				
Unlikely (242)	23.88 (17.06)	97%	22% versus 48%	60%
There is a small possibility (239)	19.43 (14.96)	20%	47% versus 22%	11%

Participants in experiments 1 and 2 judged that the positive and negative verbal probability statements conveyed approximately the same probability but completed the negative statements with more reasons against the outcome occurrence and believed that the statement conveyed less agreement and more extreme (out-of-range) outcomes. Note that, in the reason selection task, participants could only choose a reason in favour of the outcome or a reason against (hence, 91% against, entailed 9% in favour). In the consensus perception task, participants could select between three options: the scientist agreed, disagreed, or I can't say, hence the percentage values in the agrees versus disagrees column do not add up to 100%.

Negative terms imply disagreements and extreme outcomes

In experiment 1, a total of 301 UK residents allocated to four conditions completed an online questionnaire about verbal forecasts of various climate events (full description in Supplementary Information Section A). The forecasts included two negative verbal probabilities recommended by the IPCC for low probabilities ('unlikely' and 'the likelihood is low')[9] and two alternatives ('there is a small probability' and 'there is a small possibility') assumed to be positive. We expected the four verbal probabilities to convey the same numeric probability but to elicit different attention focus. An additional task (shown in Extended Data Fig. 1) tested whether the two negative verbal probabilities were more often associated with a fringe climate change outcome (from beyond the range of possible outcomes) and a final task examined whether climate scientists using positive or negative verbal probabilities were perceived to agree or disagree with their colleagues in a round-table discussion. In this study and the following, we report analyses of variance, χ^2 tests of independence and independent *t*-tests and report two-tailed *P* values for tests comparing two values.

The results show that, as expected, all four verbal probabilities were estimated to indicate probabilities in the 10–30% range, peaking around 15–20% (Table 1). An analysis of variance (ANOVA) revealed no statistically significant difference, $F(3, 300) = 2.16$, $P = 0.093$, $\eta_P^2 = 0.02$. The presumed negative verbal probabilities ('It is unlikely [the likelihood is low] that the area will be flooded, because ...') were mostly explained by con-reasons ('It is far from the river'), whereas the two presumed positive phrases were mostly completed by pro-reasons ('It is close to the river'); $\chi^2(3) = 104.93$, $P < 0.001$, $\varphi = 0.59$, Table 1, upper panel). Despite conveying a similar probability, the two negative verbal probabilities called attention to the non-occurrence of the target outcome, whereas the two positive ones attracted readers' attention towards its occurrence.

The consensus inference task showed that, when set in a hypothetical round-table discussion, a scientist using the negative probability statements describing temperature rise was perceived as indicating disagreement more often than a scientist using either of the two positive probability statements, $\chi^2(6) = 21.12$, $P = 0.002$, $\varphi = 0.27$, $V = 0.19$ (Table 1).

In the outcome selection task, participants completed the probability statement with an outcome value taken from a graphical display of sea-level rise projections ranging from 0.3 m to 1 m. The outcome chosen was categorized as moderate (within the boundaries), minimum/maximum (at the boundaries) or as extreme (beyond the range). The positive versus negative verbal probability conditions differed, $\chi^2(6) = 36.98$, $P < 0.001$, $\varphi = 0.35$, $V = 0.25$. When asked which sea-level rise magnitude was 'unlikely', most participants selected outcomes outside the confidence intervals of the climate models shown in the graph (over 1 m, or below 0.1 m). Such outcomes were also frequently selected for 'the likelihood is low' (Table 1), but not for 'a small probability' or 'a small possibility' (Supplementary Information Section B).

Experiment 2 aimed to replicate the effect of directionality on outcome selection and consensus perception. It also aimed to test the relationship between extreme outcome selection and judgements of consensus while controlling for graph comprehension. In a sample of 481 UK residents, participants were randomly allocated to two conditions: one negative (unlikely) and one positive (there is a small possibility). Participants completed the same four tasks as in experiment 1 in one of two conditions: positive (there is a small possibility) or negative (it is unlikely). To simplify the outcome selection task, we included a graph explicitly showing the number of models supporting each sea-level rise[25] and we measured graph comprehension using three questions (Extended Data Fig. 2).

https://doi.org/10.1038/s41558-025-02472-1

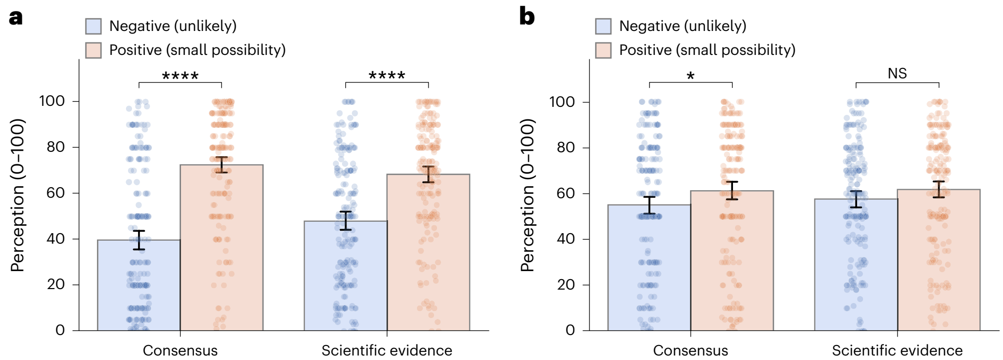


Fig. 1 | Ratings of consensus and scientific evidence for negative and positive verbal probability projections of temperature and precipitation (experiment 3, N = 414). a,b, Consensus perception (0–100 scientists) and scientific evidence judgements (0, no objective evidence; 100, fully based on objective evidence) are shown for statements about temperature rise (**a**) and precipitation decrease (**b**). ****$P < 0.0001$ and *$P < 0.05$, not significant (NS) $P > 0.05$ in independent t-tests. Bars show means, error bars show 95% CI and points show participants' responses.

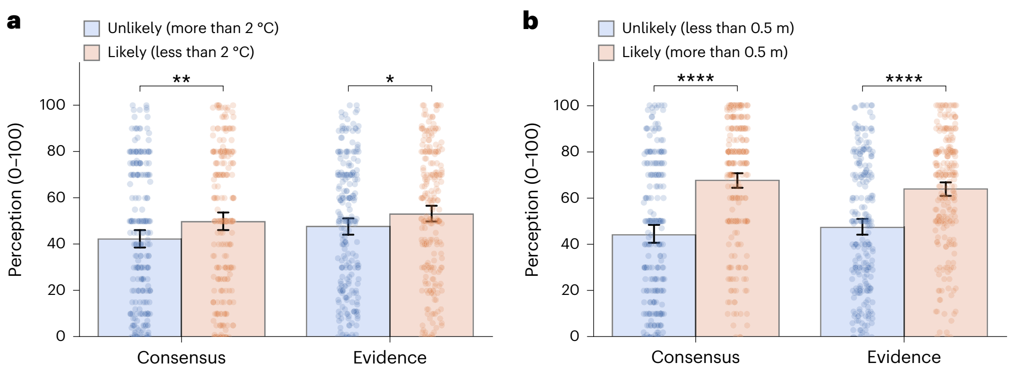


Fig. 2 | Ratings of consensus and scientific evidence for negative and positive verbal probability projections (experiment 4, N = 497). a,b, Consensus perception (0–100 scientists) and scientific evidence judgements (0, no objective evidence; 100, fully based on objective evidence) are shown for statements about temperature rise (**a**) and sea-level rise (**b**). ****$P < 0.0001$, **$P < 0.01$ and *$P < 0.05$ in independent t-tests. Bars show means, error bars show 95% CI and points show participants' responses.

Again, both verbal phrases indicated probabilities around 20%, with 'unlikely' conveying slightly higher values than 'there is a small possibility', $t(479) = 3.04$, $P = 0.003$, Cohen's $d = 0.28$ (lower panel of Table 1). Despite this, most participants associated 'unlikely' with reasons against the event occurrence, whereas 'a small possibility' was explained with reasons supporting the event occurrence, $\chi^2(1) = 293.72$, $P < 0.001$, $\varphi = 0.78$ (also Table 1).

Participants believed that a scientist describing a temperature rise as 'unlikely' disagreed with other scientists more often than when a scientist used 'a small possibility', $\chi^2(2) = 45.77$, $P < 0.001$, $\varphi = 0.31$. Furthermore, most participants in the negative condition associated 'unlikely' with extreme values (that did not occur in any models), whereas only 1 in 10 did so for 'a small possibility', $\chi^2(2) = 136.08$, $P < 0.001$, $\varphi = 0.53$. Importantly, the tendency to select extreme outcomes and to perceive disagreements were related. Of people who chose an outcome that had occurred in the model, 30% believed the speaker disagreed, against 46% of participants who selected an out-of-range value, $\chi^2(4) = 22.08$, $P < 0.001$, $\varphi = 0.21$.

Most participants (86%) correctly answered the three graph comprehension questions and could accurately identify the number of models showing different sea-level rise. Yet they selected extreme values equally often as those who failed on one or more questions. More detailed results can be found in Supplementary Information Section C.

The robustness of these findings was tested in two further experiments (experiments SI-A and SI-B) reported in Supplementary Information Sections D and E, respectively. Experiments SI-A and SI-B included a wider range of negative and positive verbal probabilities (for example, unlikely, the likelihood is low, the chance is small versus a small probability, a small chance, a small possibility), with similar results.

Negative terms suggest lower consensus and poorer evidence

The setting in the previous experiments, an imagined round-table discussion, might have facilitated perceived disagreement between adversaries. In experiment 3, climate projections were embedded in newspaper headlines about two future climate events: temperature increase in Australia and precipitation decrease in Africa (for example, 'Climate scientist says: there is a small possibility [it is unlikely] that by 2050…'). A sample of 414 UK residents assessed the perceived scientific consensus ('How many out of 100 climate scientists would agree?') and the perceived strength of supporting evidence ('How solid is the evidence for such a forecast?').

Perceived consensus was higher for positive than for negative verbal probabilities for both the temperature and precipitation projections, $t(399.37) = 11.89$, $P < 0.001$, Cohen's $d = 1.17$, $t(412) = 2.18$, $P = 0.030$, Cohen's $d = 0.21$, respectively (Fig. 1). Furthermore, consistent with our expectations, participants believed that the negative probability projections relied less on scientific evidence than the positive ones. This difference was statistically significant in the temperature rise scenario, but not in the precipitation decrease scenario, $t(404.38) = -7.85$, $P < 0.001$, Cohen's $d = 0.77$, $t(412) = -1.62$, $P = 0.107$, Cohen's $d = -0.16$. The weaker effects in this scenario could be due to its content (precipitation decrease might

https://doi.org/10.1038/s41558-025-02472-1

sound more disputable than an increase in temperatures worldwide—see experiment 5 about the role of context).

Complementary likely framing raises perceived consensus

To avoid the adverse effect of negative directionality, communicators could choose to focus on the complementary positive high probability, 'likely' event that would be expected to lead to better consensus perception. Instead of saying that a very high temperature increase is unlikely, one might say that a lower increase is likely. Examining the sixth IPCC report we find the term 'likely' used 26 times more often than 'unlikely' (Supplementary information Section F).

Participants in experiment 4 ($N = 497$ UK residents, representative for age, gender and ethnicity) reported their personal beliefs in climate change and judged outcomes based on two climate projections—temperature rise based on low GHG emissions and sea-level rise based on medium GHG emissions. The unlikely projections were taken from one tail of the distribution (more than 2 °C temperature increase and less than 0.5-m sea-level rise) and the likely ones from the middle and other tail of the distribution (less than 2 °C temperature increase and more than 0.5-m sea-level rise).

Participants believed that more scientists would agree with the 'likely' than the 'unlikely' projections and that the former also relied more strongly on scientific evidence, despite the formal equivalence of both statements (Fig. 2). Analyses of variance showed a main effect of directionality on perception of consensus and evidence, $F(1, 495) = 51.56$, $P < 0.001$, $\eta_P^2 = 0.09$; $F(1, 495) = 27.33$, $P < 0.001$, $\eta_P^2 = 0.05$. These effects remained after adding participants' climate change beliefs as a covariate (Supplementary Information Section F). We also identified a main effect of the climate outcome (judgements were more negative for the low-emission pathway temperature projections than the medium-emission pathway sea-level rise) and a predicted interaction effect between verbal probabilities and the climate change outcome (Supplementary Information Section F).

Positive terms and numerical ones raise perceived consensus

Experiment 5 tested (1) the robustness of verbal directionality effects for projections described as issued by IPCC; (2) the drawback of projections reframed as 'likely'; and (3) the directionality of numerical probability expressions (expected to be positive). Overall, 802 participants from a UK representative sample (quota sampling for gender, age and political preference) read and judged one of four temperature projections, all stated to be issued by the IPCC: an 'unlikely' and a 'small probability' projection of warming reaching 3 °C, a corresponding numerical 10–33% probability projection and a 'likely' projection of temperatures not reaching 3 °C. Participants evaluated consensus (out of 100 scientists), attention focus (occurrence vs non-occurrence) and degree of concern.

Participants estimated different levels of consensus across projections, $F(3, 801) = 31.73$, $P < 0.001$, $\eta^2 = 0.11$ (Table 2). They inferred more consensus for the 'small probability' and the numerical probability projections than for the 'unlikely' and 'likely… not' projections (pairwise comparisons in Supplementary Information Section G). These effects were independent of individual differences in knowing the IPCC, education level and political conservatism (Supplementary Information Section G).

Reported outcome focus was clearly dependent on the wording of the statement, $\chi^2(2) = 135.06$, $P < 0.001$, $\varphi = 0.41$ (Table 2). 'A small probability' and the 10–33% numerical probability directed attention to the possibility that the outcome might happen, whereas the 'unlikely' and 'likely… not' pointed to the possibility that it might not happen.

Contrary to our expectations, levels of concern caused by the projections did not differ across conditions, $F(3, 801) = 1.13$, $P = 0.337$, $\eta_P^2 < 0.01$ (Table 2). One participant commented that the negative frame could cause alarm by suggesting denial of the severity of the event. Hence, it is possible that positive and negative verbal probabilities could cause alarm for different reasons.

Table 2 | Perceived consensus, event focus and concerns based on four IPCC projections about a global warming of 3 °C according to the medium GHG emissions scenario (experiment 5)

The IPCC says…	Mean consensus (s.d.)	% event occurrence focus (vs non-occurrence)	Mean concerns (s.d.)
It is unlikely global warming will reach 3 °C (n=201)	42.10 (28.18)	34%[a]	2.64 (0.98)
There is a small probability global warming will reach 3 °C (n=199)	59.42 (28.74)	75%[b]	2.66 (0.94)
There is a 10–33% probability global warming will reach 3 °C (n=202)	61.79 (27.90)	79%[b]	2.80 (0.99)
It is likely that global warming will not reach 3 °C (n=200)	40.35 (28.43)	39%[a]	2.70 (0.96)

[a,b]Subgroups that are statistically different from each other in Z tests ($P < 0.05$).

Prior beliefs as boundary conditions

Experiment 6 tested whether the effects of directionality on perceived consensus, evidence support and climate change concerns are moderated by prior beliefs and knowledge about climate change in a sample of 873 UK residents (representative based on quota sampling for gender, age and political voting preference). To introduce variation in participants' familiarity and prior beliefs, we included projections about temperature and winter precipitation changes, with the former expected—and found—to be more familiar. In addition, in a between-subjects design, we manipulated the GHG emission levels underpinning the projections. Low-emission projections were expected to clash more with participants' beliefs than high-emission projections—which they did. We report baseline perceptions in Supplementary Information Section H.

For the temperature projection (Fig. 3, upper panel), directionality had the expected effect on consensus, scientific evidence and concerns (Table 3). Participants perceived higher consensus and scientific evidence and reported greater concerns about climate change in the positive than in the negative condition. The effect of directionality was larger in the low GHG emission than in the high-emission scenario condition (where it was not significant). For UK winter precipitation, the effect of directionality was smaller and only statistically significant for concerns (Table 3). These variations can be explained by participants' baseline expectations about the outcomes. Negative (versus positive) directionality led to more negative perceptions when the projected values were believed to actually be likely to occur (for example, participants expected temperatures to warm more than the low GHG estimates). Projected values that were higher than participants' expectations (for example, based on high GHG emissions) showed smaller or null effects of directionality.

Discussion

Uncertainty is inherent to scientific endeavours and how it should be communicated to the public represents an important challenge[8]. It should not fuel false beliefs about a lack of agreement between climate scientists[30–32]. A body of findings suggests that admitting uncertainty (versus appearing confident) suggests a lack of competence[33–36], whereas other studies indicate that admitting uncertainty might

https://doi.org/10.1038/s41558-025-02472-1

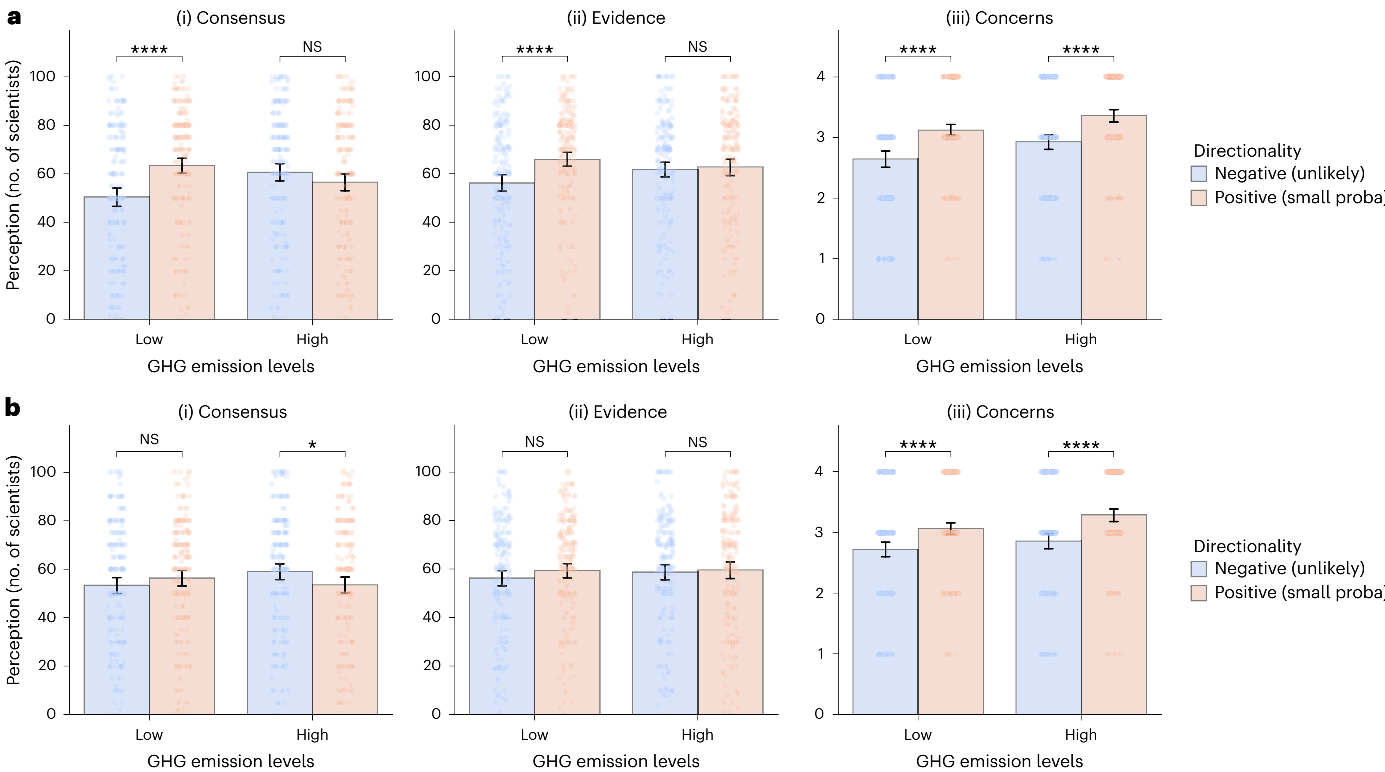


Fig. 3 | Perceived consensus, evidence and concerns for positive and negative climate projections about temperature and winter precipitation projections in experiment 6 (*N* = 872 participants). a,**b**, Consensus perception (0–100 scientists) (i), scientific evidence judgement (0, no objective evidence; 100, fully based on objective evidence) (ii) and concerns (1, not at all; 4: completely) (iii) for temperature projections (**a**i–**a**iii) and winter precipitation projections (**b**i–**b**iii) based on low versus high greenhouse gas emission scenario (GHG). ****$P < 0.0001$, *$P < 0.05$, not significant (NS) $P > 0.05$ in independent *t*-tests. Bars show means, error bars show 95% CI and points show participants' responses.

actually increase people's trust in scientists[37,38]. We show here that how uncertainty is communicated plays an important role in shaping these effects.

Consistent with past research[15,16,19], we found that negatively framed expressions, such as the IPCC-recommended terms 'unlikely' and 'the likelihood is low'[9], divert people's attention away from the occurrence of the target outcome and make it appear insignificant. A low probability but potentially impactful hazard described negatively may accordingly be downplayed as an event that will not happen (experiments 1, 2 and 4) and/or can be taken lightly (experiment 5). This dismissal is reinforced by the implied extremity of the outcome: prototypical 'unlikely' outcomes are pictured as exceptional (experiments 1, 2 and experiment SI-A of Supplementary Information Section D). Importantly, we provide evidence that in addition, unlikely projections are perceived as expressing more dissent (experiments 1–6 and experiments SI-A and SI-B of Supplementary Information Sections D and E) and are believed to be less based on solid scientific evidence (experiments 2, 3 and 5) than the same projections expressed in positive, affirmative terms. This adds to other drawbacks of negations, which have previously been associated with wider variability in interpretation[39] and less cautious decisions[19].

Results also addressed the role of personal beliefs. While 'unlikely' projections consistently shifted attention away from the outcome and reduced concerns, their effect on perceived consensus and scientific evidence was more dependent on context and prior beliefs. Projections that were far off from people's prior beliefs and expectations were less affected by how low probabilities were phrased (experiment 6). Self-assessed knowledge about climate change did not attenuate the directionality effects in a sample of UK adults, but further research should test whether these effects generalize to climate scientists and policy-makers.

Instead of describing unexpected outcomes or rare events as 'unlikely', climate scientists could adhere to IPCC guidelines by characterizing their complements as being 'likely'. This seems to be the frame preferred by IPCC authors[9] who used 'likely' much more frequently than 'unlikely'. However, this usage would not help raise people's awareness and concerns about such potentially important issues (experiments 4 and 5) and it might even lead to lower perceived consensus when it features a negation (experiment 5), or to an increase in uncertainty when focusing on a wider estimate[33].

We recommend using affirmative low-probability expressions (for example, 'a low probability of severe drought') whenever possible and favouring them over high-probability expressions of outcome complements ('a high probability that severe drought will not occur'). Affirmative low-probability terms refer directly to the target event, rather than negating it, aligning more closely with numeric probability ranges (10–33% probability), which are often regarded as more scientific and trustworthy[40,41].

Our studies showcase the importance of studying verbal uncertainty beyond their quantitative interpretations[42,43]. The implicit meaning of negative (vs positive) verbal phrases tends to be overlooked, but it might include information about speaker's attitude and recommendation[16] or about the nature of the event[44,45]. Negative verbal probabilities are not inherently inappropriate or misleading. They could be effective in conveying that a claim lacks support and can be put aside (for example, 'it is unlikely that the current climate change is natural'). It is essential to consider and explore pragmatic aspects of our estimative lexicon when developing scales and guidelines. Verbal probabilities are a toolbox, from which science communicators should choose carefully.

Communicating clearly how much climate change scientists agree about different possible outcomes is essential to inform citizens and policy-makers. Uncertainty should not fuel scepticism[46], but serve as an

 https://doi.org/10.1038/s41558-025-02472-1

Table 3 | Effect of directionality ('unlikely' versus 'a small probability') for temperature and precipitation rise as a function of emission levels (low versus high) on consensus perception, scientific evidence and concerns about climate change (experiment 6, *N*=872)

	Consensus		Evidence		Concerns	
Temperature	$F(1, 754)$	η_P^2	$F(1, 754)$	η_P^2	$F(1, 754)$	η_P^2
Directionality	6.97**	0.01	9.60**	0.01	59.95***	0.07
Emissions	1.12	<0.01	0.38	<0.01	15.79***	0.02
Directionality×emissions	19.74***	0.03	8.45**	0.01	0.001	<0.01
Baseline control (cov)						
Expertise	0.23	<0.01	0.04	<0.01	0.06	<0.01
Trust	2.96	<0.01	36.61***	0.05	<0.01	<0.01
Expected magnitude	0.02	<0.01	0.001	0.975	8.42**	0.01
Consensus about event	13.52***	0.02	12.61***	0.02	0.03	<0.01
Media coverage	1.11	<0.01	1.01	<0.01	28.02***	0.04
Precipitation	$F(1, 612)$	η_P^2	$F(1, 612)$	η_P^2	$F(1, 612)$	η_P^2
Directionality	0.11	<0.01	1.09	<0.01	32.86***	0.05
Emissions	0.002	<0.01	1.75	<0.01	9.48**	0.02
Directionality×emissions	4.30*	0.01	0.46	<0.01	0.06	<0.01
Baseline control (cov)						
Expertise	0.14	<0.01	0.53	<0.01	0.59	<0.01
Trust	8.12**	0.01	59.56***	0.01	0.57	<0.01
Expected magnitude	0.001	<0.01	3.41	0.01	1.32	<0.01
Consensus about event	5.00*	0.01	5.11*	0.01	0.63	<0.01

*$P<0.05$, **$P<0.01$, ***$P<0.001$. The varying sample size between the temperature and the precipitation statements is related to excluded values (for example, 'don't know' answers to the baseline questions).

informative and useful component of risk communication. We provide evidence that by using negative verbal probabilities, the IPCC and other organizations (for example, EFSA[12], NATO[13] and FASB[14]) might unknowingly undermine the information they aim to convey. When communicating low-probability outcomes that are supported by scientific evidence, positive verbal probabilities should be preferred, as they are more likely to signal stronger scientific consensus and evidential support.

Online content

Any methods, additional references, Nature Portfolio reporting summaries, source data, extended data, supplementary information, acknowledgements, peer review information; details of author contributions and competing interests; and statements of data and code availability are available at https://doi.org/10.1038/s41558-025-02472-1.

References

1. Boykoff, M. T. & Rajan, S. R. Signals and noise: mass-media coverage of climate change in the USA and the UK. *EMBO Rep.* **8**, 207–211 (2007).
2. van der Linden, S. L., Leiserowitz, A. A., Feinberg, G. D. & Maibach, E. W. The scientific consensus on climate change as a gateway belief: experimental evidence. *PLoS ONE* **10**, e0118489 (2015).
3. Maibach, E., Myers, T. & Leiserowitz, A. Climate scientists need to set the record straight: there is a scientific consensus that human-caused climate change is happening. *Earth's Future* **2**, 295–298 (2014).
4. Cook, J. et al. Quantifying the consensus on anthropogenic global warming in the scientific literature. *Environ. Res. Lett.* **8**, 024024 (2013).
5. Farrell, J. The growth of climate change misinformation in US philanthropy: evidence from natural language processing. *Environ. Res. Lett.* **14**, 034013 (2019).
6. Porter, E., Wood, T. J. & Bahador, B. Can presidential misinformation on climate change be corrected? Evidence from Internet and phone experiments. *Res. Politics* **6**, 2053168019864784 (2019).
7. Benegal, S. D. & Scruggs, L. A. Correcting misinformation about climate change: the impact of partisanship in an experimental setting. *Clim. Change* **148**, 61–80 (2018).
8. Gustafson, A. & Rice, R. E. A review of the effects of uncertainty in public science communication. *Public Understand. Sci.* **29**, 614–633 (2020).
9. IPCC. *Climate Change 2021: The Physical Science Basis* (eds Masson-Delmotte, V. et al.) (Cambridge Univ. Press, 2021).
10. IPCC. *Climate Change 2013: The Physical Science Basis* (eds Stocker, T. F. et al.) (Cambridge Univ. Press, 2013).
11. Mastrandea, M. D. et al. *Guidance Note for Lead Authors of the IPCC Fifth Assessment Report on Consistent Treatment of Uncertainties* (IPCC, 2010).
12. European Food Safety Authority et al. Guidance on communication of uncertainty in scientific assessments. *EFSA J.* **17**, e05520 (2019).
13. *Allied Joint Doctrine for Intelligence Procedures AJP-2.1* (North Atlantic Treaty Organization, 2016).
14. Financial Accounting Standards Board. *Statement of Financial Accounting Standards No. 5: Accounting for Contingencies* (Financial Accounting Standards Board, 1984).
15. Teigen, K. H. & Brun, W. The directionality of verbal probability expressions: effects on decisions, predictions, and probabilistic reasoning. *Organ. Behav. Hum. Decis. Process.* **80**, 155–190 (1999).
16. Teigen, K. H. & Brun, W. Yes, but it is uncertain—direction and communicative intention of verbal probabilistic terms. *Acta Psychol.* **88**, 233–258 (1995).
17. Kemp, L. et al. Climate endgame: exploring catastrophic climate change scenarios. *Proc. Natl Acad. Sci. USA* **119**, e2108146119 (2022).

18. Sirota, M. & Juanchich, M. Risk communication on shaky ground. *Science* **338**, 1286–1287 (2012).
19. Juanchich, M., Shepherd, T. G. & Sirota, M. Negations in climate-change uncertainty lexicon affect framing perspective, decision making and trust. *Clim. Change* **162**, 1677–1698 (2020).
20. Teigen, K. H., Brun, W. & Frydenlund, R. Judgments of risk and probability: the role of frequentistic information. *J. Behav. Decis. Mak.* **12**, 123–139 (1999).
21. Levin, I. P., Schneider, S. L. & Gaeth, G. J. All frames are not created equal: a typology and critical analysis of framing effects. *Organ. Behav. Hum. Decis. Process.* **76**, 149–188 (1998).
22. Juanchich, M., Teigen, K. H. & Villejoubert, G. Is guilt 'likely' or 'not certain'? Contrast with previous probabilities determines choice of verbal terms. *Acta Psychol.* **135**, 267–277 (2010).
23. Teigen, K. H. & Juanchich, M. Do claims about certainty make estimates less certain? *Cognition* **252**, 105911 (2024).
24. Teigen, K. H., Juanchich, M. & Riege, A. Improbable outcomes: infrequent or extraordinary? *Cognition* **127**, 119–139 (2013).
25. Juanchich, M. & Sirota, M. How much will the sea level rise? Outcome selection and subjective probability in climate change predictions. *J. Exp. Psychol. Appl.* **23**, 386–402 (2017).
26. Jenkins, S. C., Harris, A. J. L. & Lark, R. M. Understanding 'unlikely (20% likelihood)' or '20% likelihood (unlikely)' outcomes: the robustness of the extremity effect. *J. Behav. Decis. Mak.* **31**, 572–586 (2018).
27. Teigen, K. H., Juanchich, M. & Løhre, E. What is a "likely" amount? Representative (modal) values are considered likely even when their probabilities are low. *Organ. Behav. Hum. Decis. Process.* **171**, 104166 (2022).
28. Juanchich, M., Sirota, M. & Teigen, K. H. People prefer to predict middle, most likely quantitative outcomes (not extreme ones), but they still over-estimate their likelihood. *Q. J. Exp. Psychol.* **76**, 2629–2649 (2023).
29. Juanchich, M., Teigen, K.-H., Sirota, M. & Shepherd, T. G. Effect of directionality on consensus perception. Project preregistration, materials, data and analytical code. Open Science Framework https://doi.org/10.17605/OSF.IO/CH4WF (2025)
30. Alvarez, R. M., Debnath, R. & Ebanks, D. Why don't Americans trust university researchers and why it matters for climate change. *PLoS Clim.* **2**, e0000147 (2023).
31. van der Linden, S. The Gateway Belief Model (GBM): a review and research agenda for communicating the scientific consensus on climate change. *Curr. Opin. Psychol.* **42**, 7–12 (2021).
32. Maertens, R., Anseel, F. & van der Linden, S. Combatting climate change misinformation: evidence for longevity of inoculation and consensus messaging effects. *J. Environ. Psychol.* **70**, 101455 (2020).
33. Løhre, E., Juanchich, M., Teigen, K. H., Sirota, M. & Shepherd, T. G. Climate scientists' wide prediction intervals may be more likely but are perceived to be less certain. *Weather Clim. Soc.* **11**, 565–575 (2019).
34. Thomas, J. P. & McFadyen, R. G. The confidence heuristic: a game-theoretic analysis. *J. Econ. Psychol.* **16**, 97–113 (1995).
35. Løhre, E., Chandrashekar, S. P., Mayiwar, L. & Hærem, T. Uncertainty, expertise, and persuasion: a replication and extension of Karmarkar and Tormala (2010). *J. Exp. Soc. Psychol.* **113**, 104619 (2024).
36. Han, P. K. et al. Communication of uncertainty regarding individualized cancer risk estimates: effects and influential factors. *Med. Decis. Mak.* **31**, 354–366 (2011).
37. Petersen, M. B., Bor, A., Jørgensen, F. & Lindholt, M. F. Transparent communication about negative features of COVID-19 vaccines decreases acceptance but increases trust. *Proc. Natl Acad. Sci. USA* **118**, e2024597118 (2021).
38. Steijaert, M. J., Schaap, G. & Riet, J. V. T. Two-sided science: communicating scientific uncertainty increases trust in scientists and donation intention by decreasing attribution of communicator bias. *Communications* **46**, 297–316 (2021).
39. Smithson, M., Budescu, D. V., Broomell, S. B. & Por, H.-H. Never say "not:" impact of negative wording in probability phrases on imprecise probability judgments. *Int. J. Approx. Reason.* **53**, 1262–1270 (2012).
40. Nakao, M. A. & Axelrod, S. Numbers are better than words. Verbal specifications of frequency have no place in medicine. *Am. J. Med.* **74**, 1061–1065 (1983).
41. Gurmankin, A. D., Baron, J. & Armstrong, K. The effect of numerical statements of risk on trust and comfort with hypothetical physician risk communication. *Med. Decis. Mak.* **24**, 265–271 (2004).
42. Budescu, D. V., Por, H.-H., Broomell, S. B. & Smithson, M. The interpretation of IPCC probabilistic statements around the world. *Nat. Clim. Change* **4**, 508–512 (2014).
43. Budescu, D. V., Por, H.-H. & Broomell, S. B. Effective communication of uncertainty in the IPCC reports. *Clim. Change* **113**, 181–200 (2012).
44. Juanchich, M., Gourdon-Kanhukamwe, A. & Sirota, M. 'I am uncertain' or 'It is uncertain'? How linguistic markers of the uncertainty source affect uncertainty communication. *Judgm. Decis. Mak.* **12**, 445–465 (2017).
45. Ülkümen, G., Fox, C. R. & Malle, B. F. Two dimensions of subjective uncertainty: clues from natural language. *J. Exp. Psychol. Gen.* **145**, 1280–1297 (2016).
46. Howe, L. C., MacInnis, B., Krosnick, J. A., Markowitz, E. M. & Socolow, R. Acknowledging uncertainty impacts public acceptance of climate scientists' predictions. *Nat. Clim. Change* **9**, 863–867 (2019).

Methods

All the studies were preregistered. Preregistrations, materials, data and analytical code are available on the Open Science Framework at https://osf.io/ch4wf/ (ref. 29).

Method experiment 1

Participants. Overall, 301 UK residents were recruited from Prolific for an online questionnaire, which they all completed fully and met the preregistered minimal completion time (>1.5 min for a study that had a median completion time of 5 min). The sample size provides sufficient power to detect a small–medium effect in a chi-square test comparing four groups with 90% power (alpha = 5%, Cohen's w = 0.21, two-sided test). Participants were between 18 years old and 76 years old (M = 39.53, s.d. = 13.13), 50% men, 49% women, 1% non-binary and 0.3% preferred not to say. Information about education, ethnicity and English proficiency is provided in Supplementary Information Section A.

Design, materials and procedure. Participants read projections concerning low-probability climate-related outcomes in four separate tasks (a probability task, a directionality task, an outcome selection task and a consensus task). In each task, climate change-related outcomes were described with one of four verbal probabilities presumed to be either negative or positive (between-subjects random allocation within each task):

- Negative verbal probabilities
  - It is unlikely that…
  - The likelihood is low that…
- Positive verbal probabilities
  - There is a small probability that…
  - There is a small possibility that…

The two verbal probabilities assumed to be negative are both recommended by the IPCC to describe probabilities in the 0–33% range[9]. The 'low likelihood' terminology was introduced in the 2021 IPCC report[9], where it was used more often than 'unlikely' (115 versus 99 times). 'There is a small probability' has been shown to be positive and to convey the same probability as 'unlikely'[19]. Possibilities and probabilities are not the same[47], but when graded, 'There is a small possibility' was expected to convey a similar expectation as 'a small probability' and to retain a positive directionality.

Probability task. The assumed probabilistic equivalence was tested by asking participants to 'translate' the verbal phrases into corresponding numeric probabilities. Each participant provided their judgements about one of the four phrases (random allocation) on a sliding scale ranging from 0% (labelled 'impossible') to 100% ('certain').

Directionality task. Directionality was tested by sentence completion, asking participants to select the most appropriate of two opposite reasons, related to a flood forecast. The statement to be explained included one of the four verbal probabilities (random allocation). For instance, 'It is unlikely that the area will be flooded, because…'. Participants could choose a reason supporting the occurrence of flood ('It is close to the river'), or a reason against flood ('It is far from the river'). Supporting reasons indicated that the verbal probability had a positive (affirmative) directionality, whereas reasons against indicated a negative directionality. Then, participants read the consensus and outcome tasks, presented in random order.

Consensus task. Participants were asked to imagine a TV round-table discussion with several climate scientists. One of them stated how much warmer the climate would be in the year 2100, saying: 'It is unlikely [the likelihood is low] [there is a small probability] [there is a small possibility] that temperature will rise 3 degrees Celsius'. On the basis of this statement, participants assessed whether this scientist agreed with the other scientists. Participants could answer that the scientist probably 'agreed', 'disagreed' or that it was 'impossible to say'.

Outcome selection task. Participants read about projected sea-level rise between 2000 and 2100, accompanied by the IPCC Figure SPM.6 sea-level rise projections[48] shown in Extended Data Fig. 1. The graph shows mean estimates of sea-level rise along with their frequencies in the projections (ranging from 0.25 m to 0.95 m). Participants selected an outcome value to complete a probability statement that featured one of the four verbal probabilities (for example, 'It is unlikely that the sea-level will rise by… metres'). Participants could select the outcome from a list of eight values spanning from below the range shown in the graph (0–0.2) up to values from above the range (>1.4 m) in intervals of 0.2 m as shown in Extended Data Fig. 1. Answers falling outside the range of the confidence intervals (≤0.2 m and ≥1 m) were coded as out of range, extreme values. Values from the lower and upper part of the confidence intervals (0.2–0.4 and 0.8–1.0 m) were coded as minimum/maximum values, whereas less extreme values within the uncertainty intervals were coded as moderate.

Method experiment 2

Participants. Overall, 481 participants, recruited by Prolific, completed the study fully and they all met the completion time that we deemed appropriate (>1.5 min for a study that had a median completion time of 4 min). The sample size provides sufficient power to detect a small–medium effect in a chi-square test comparing two groups with 90% power (alpha = 5%, Cohen's w = 0.15, two-sided test). Participants were between 20 years old and 82 years old (M = 42.77, s.d. = 13.67), 50% men, 49% women, 1% non-binary and 0.2% preferred not to say. Information about education, ethnicity and English proficiency is provided in Supplementary Information Section A.

Design, material and procedure. Participants completed four tasks in one of two conditions: negative (it is unlikely) or positive (there is a small possibility). The study included the same four tasks as experiment 1 (probability perception, directionality, consensus and outcome selection). We only adapted the outcome selection task, so that it featured a simpler bar chart presenting the outcomes of 200 models showing sea-level rise between 50 cm and 90 cm with a peak at 70 cm (ref. 25) (Extended Data Fig. 2). Participants selected the sea-level rise that seemed most appropriate to complete a probability statement that included either 'unlikely' or 'a small possibility'. The outcome selection task, was followed by three graph comprehension questions on a separate page. The questions tested participants' ability to read the number of models supporting different sea-level rise magnitudes from the graph: 'Based on the graph, how many models show each of the following sea-level rise magnitudes: 50 cm? 70 cm? 100 cm?'

Method experiment 3

Participants. Overall, 414 participants, recruited from Prolific, completed the study fully and they all met the completion time that we deemed appropriate (>40 s for a study that had a median completion time of 1.7 min). The sample size provides sufficient power to detect a small–medium effect in a between-subjects t-test comparing two groups with 90% power (alpha = 5%, Cohen's d = 0.29, two-sided test). Participants were between 18 years old and 74 years old (M = 41.21, s.d. = 12.14), 48% men, 51% women, 0.2% non-binary and 0.2% preferred not to say. Information about education, ethnicity and English proficiency provided in Supplementary Information Section A.

Design, materials and procedure. Participants were randomly allocated to a negative or a positive condition (that is, 'unlikely' versus 'a small possibility') within each of two short scenarios. In each scenario, participants imagined that they read a climate projection as the headline in a newspaper they trusted.

For the temperature rise scenario, participants read: 'Climate scientist says: There is a small possibility [it is unlikely] that by 2050 the temperature in Australia will be 2 degrees warmer than this year'; 206 participants read the positive version and 208 the negative one. For the precipitation decrease scenario, participants read: 'Climate scientist says: There is a small possibility [it is unlikely] that precipitation will decrease by 20% in the next decade in Africa'; 207 participants read the positive version and 207 the negative one.

We gauged perceived consensus by asking participants to estimate how many out of 100 climate scientists agreed with the statements. This estimate was followed by a question about perceived evidence: 'To what extent do you think the prediction is based on objective scientific evidence?', to be answered on a scale ranging from 0 (not based on objective evidence at all) to 100 (fully based on objective evidence).

Method experiment 4

Participants. We used quota sampling via Prolific for the sample to be representative of the UK population, based on the census data related to sex, age and ethnicity. Overall, 497 participants completed the study fully and they all met the completion time that we deemed appropriate (>49 s for a study that had a median completion time of 2 min). The sample size provides sufficient power to detect a small–medium effect in a between-subjects *t*-test comparing two groups with 90% power (alpha = 5%, Cohen's $d = 0.26$, two-sided test). Participants were between 18 years old and 79 years old ($M = 46.61$, s.d. = 15.47), 50% men, 51% women, 0.4% non-binary and 0.4% preferred not to say. Information about education, ethnicity, English proficiency and climate change belief is provided in Supplementary Information Section A.

Design, materials and procedure. Participants assessed the consensus and evidence base of a statement about sea-level rise and temperature rise. Each projection either included an 'unlikely' outcome (a narrow range from the tail of the distribution) or a 'likely' outcome (that is, a wider complementary range) based on the IPCC report[9] (random allocation). To avoid fully confounding the width of the range (larger versus narrower) with the position of the range within the distribution (upper versus lower), we crossed the manipulation in the temperature and sea-level contexts as follows (differences across conditions underlined).

Temperatures: 'Under a low greenhouse gas emission scenario, …

(A) <u>it is unlikely</u> that the temperature in 2100 will be <u>more than</u> 2 °C warmer than in 1950' [$n = 251$]
(B) <u>is likely</u> that the temperature in 2100 will be <u>less than</u> 2 °C warmer than in 1950' [$n = 246$]

Sea level: 'Relative to 1950, under a moderate greenhouse gas emission scenario, …

(A) <u>it is unlikely</u> the sea level will rise by <u>less than</u> 0.5 m by 2100' [$n = 251$]
(B) <u>it is likely</u> the sea level will rise by <u>more than</u> 0.5 m by 2100' [$n = 246$]

Estimates of consensus and scientific evidence were measured on 0–100 scales as in experiment 3. Participants also reported their climate change beliefs, as answers to an item drawn from ref. 49. 'How likely do you think it is that global warming is occurring now?' rated on a scale ranging from 1 (very unlikely) to 5 (very likely).

'More-than' outcomes are believed to function like assertions, whereas 'less-than' outcomes function more like negations[50–52]—akin to positive versus negative verbal probabilities. Hence, as a secondary preregistered hypothesis, we also expected an interaction effect between the directionality of the verbal probability and the interval in focus ('more than' versus 'less than'). This interaction entails that a 'likely more-than' projection would result in higher consensus judgements than other combinations of verbal probability and outcome frame.

Method experiment 5

Participants. The sample was representative of the UK population based on quota sampling for gender, age and political orientation. Overall, 802 participants completed the study fully and they all met the minimal completion time requirement (>44 s for a study that had a median completion time of 2 min). The sample size provides sufficient power to detect a small effect in an ANOVA testing the effect of format (four groups) with 90% power (alpha = 5%, Cohen's $f = 0.13$, two-sided test) and a small correlation when testing the role of individual differences in political orientation ($\rho = |\,0.10\,|$). We increased the sample size to better detect the potential interaction effects (for example, directionality × IPCC awareness), which typically require larger samples than main effects. Participants were between 18 years old and 87 years old ($M = 46.00$, s.d. = 15.72), 47% men, 52% women, 0.4% non-binary, 0.4% preferred not to say. Information about education, ethnicity, English proficiency, political preference and IPCC awareness is provided in Supplementary Information Section A.

Design, materials and procedure. Our previous experiments focused on climate change statements made by scientists and showed a substantial effect of directionality on consensus perception. However, given that the IPCC provides an overview of scientific evidence that is agreed upon, it is possible that subtle ways to frame information would not impact recipients' consensus perception. Here we present the information as coming from the IPCC directly, to test the robustness of previous findings.

Participants were randomly allocated to one of the four statement conditions: 'According to the Intergovernmental Panel on Climate Change, under the medium greenhouse gas emissions scenario…

(1) it is unlikely that global warming will reach 3 °C'
(2) there is a small probability that global warming will reach 3 °C'
(3) there is a 10–33% probability that global warming will reach 3 °C'
(4) it is likely that global warming will not reach 3 °C'

After reading the projection, participants made three judgements in a set order. First, consensus: how many out of 100 climate scientists they thought agreed with the statements. Awareness of the implied focus of the message: 'Do you think the prediction attracts readers' attention to the possibility that global warming might reach 3 °C or to the possibility that it might not reach 3 °C?'. Finally, participants reported their concerns on a four-point scale ranging from 1 (not concerned at all) to 4 (extremely concerned): 'Given the prediction, how concerned are you about the potential consequences of climate change?'. In the last block, before answering some sociodemographic questions, participants answered (Yes or No) to three questions about their familiarity with the IPCC. They reported whether they had heard of it, whether they had read information from the IPCC second-hand (for example, in the news) or first-hand (for example, reading from the report/website).

Method experiment 6

Participants. The sample was representative of the UK population based on quota sampling for gender, age and political orientation (via Prolific). Overall, 877 participants completed the study fully, but 4 were excluded for completing the study in less than 90 s (median completion time of 4 min). The sample size of 873 provides sufficient power to detect a small effect in an ANOVA with 90% power (d.f. = 3, groups = 4, alpha = 5%, Cohen's $f = 0.13$), a small correlation when testing the role of individual differences in political orientation ($\rho = |0.10|$). Of the sample of 873, participants were between 18 years old and 87 years old ($M = 45.67$, s.d. = 15.26 yr), 48% men, 51% women, 0.1% non-binary, 0.2% preferred not to say. Information about education, ethnicity, English proficiency, political preference and climate subjective expertise is provided in Supplementary Information Section A.

Design, materials and procedure. *Baseline control measures*. Participants first answered a series of eight baseline questions related to climate change presented in two blocks. In the first block, participants answered three checking questions about temperature change (assumed to be a more familiar issue) and about winter precipitation changes (less familiar), presented on separate pages in counterbalanced order. Participants rated how much news coverage the event received (1, very rarely, to 5, very often), the scientific consensus about the event (1, the scientists do not agree, to 4, the scientists completely agree; 99, I don't know) and the magnitude of the expected change (from a value below the likely value based on low-emission scenarios to a value above likely values with high emissions). Participants could also specify their own values or select 'I don't know'. The order of the questions was randomized for each participant. In the second block, participants reported their level of expertise in climate change (0, not at all informed, to 10, very well informed) and their global trust in climate change scientists (1, not at all, to 5, very strongly) (counterbalanced order).

Perception of the climate statements. Then, participants read and made judgements based on two climate statements presented as being taken from an unnamed newspaper that participants trusted (as in experiment 3). The statements varied according to a mixed-factorial design with 2 directionality (between: negative versus positive) × 2 outcome (within: temperature versus winter precipitation) × 2 GHG emission levels (between: high versus low). Hence, participants read a statement about temperature and one about winter precipitation and the statements either featured a positive directionality based on low or high GHG emission ($n = 224$ and $n = 218$) or a negative directionality based on low or high emission ($n = 214$ and $n = 217$). See Supplementary information Section G for information on projection selection. The projections read as follows:

Temperature: 'Scientist says that relative to the 1990s and based on current trend in greenhouse gas emissions [low greenhouse gas emissions], by 2100: It is unlikely [there is a small probability] that temperature rise will exceed 4.1 °C [2.3 °C] in the UK'.

Winter precipitation: 'Scientist says that relative to the 1990s and based on current trend in greenhouse gas emissions [low greenhouse gas emissions], by 2100: It is unlikely [there is a small probability] that winter precipitation will increase by 32% [18%] in the UK'.

On the basis of the projection, participants assessed scientific consensus as in experiments 3–5 (out of 100 climate scientists, how many would agree with this prediction?). Participants also assessed whether the statement relied on scientific evidence: 'To what extent do you think the prediction is based on objective scientific evidence?', to be answered on a scale ranging from 0, not based on objective evidence at all, to 100, fully based on objective evidence (as in experiments 3 and 4). Finally, participants assessed how much concerns and action the statement aimed to trigger (measured on a four-point scale ranging from 1, not at all, to 4, completely). The concern question was adapted to focus on the aim of the statement, in contrast with concerns felt by the participants based on the statement, because some participants perceived that the expression of a lack of concerns was alarming in experiment 5.

Ethics statement
The studies received ethical approval from the University of Essex (first and last authors' institution ethics board). Participants provided informed consent before taking part in all our studies.

Reporting summary
Further information on research design is available in the Nature Portfolio Reporting Summary linked to this article.

Data availability
All the studies were preregistered and preregistrations, materials, data and analytical code are available on the Open Science Framework at https://osf.io/ch4wf/ (ref. 29).

Code availability
Analytical code is available on the Open Science Framework at https://osf.io/ch4wf/ (ref. 29).

References
47. van der Helm, R. Towards a clarification of probability, possibility and plausibility: how semantics could help futures practice to improve. *Foresight* **8**, 17–27 (2006).
48. IPCC. *Climate Change 2014: Synthesis Report* (eds Core Writing Team, Pachauri, R. K. & Meyer, L. A.) (IPCC, 2014).
49. Heath, Y. & Gifford, R. Free-market ideology and environmental degradation. *Environ. Behav.* **38**, 48–71 (2006).
50. Hoorens, V. & Bruckmüller, S. Less is more? Think again! A cognitive fluency-based more-less asymmetry in comparative communication. *J. Personal. Soc. Psychol.* **109**, 753–766 (2015).
51. Teigen, K. H. Dimensions of uncertainty communication: what is conveyed by verbal terms and numeric ranges. *Curr. Psychol.* **42**, 29122–29137 (2023).
52. Matthews, W. J. & Dylman, A. S. The language of magnitude comparison. *J. Exp. Psychol. Gen.* **143**, 510 (2014).

Author contributions
M.J. contributed to the conceptualization of the studies, curated the data, conducted the formal analysis, secured funding, carried out the investigation, developed the methodology, administered the project, provided resources, created the visualizations, drafted the original paper and participated in writing, reviewing and editing. K.H.T., T.G.S. and M.S. contributed to the conceptualization and methodology of the studies, provided resources and participated in writing, reviewing and editing.

Competing interests
The authors declare no competing interests.

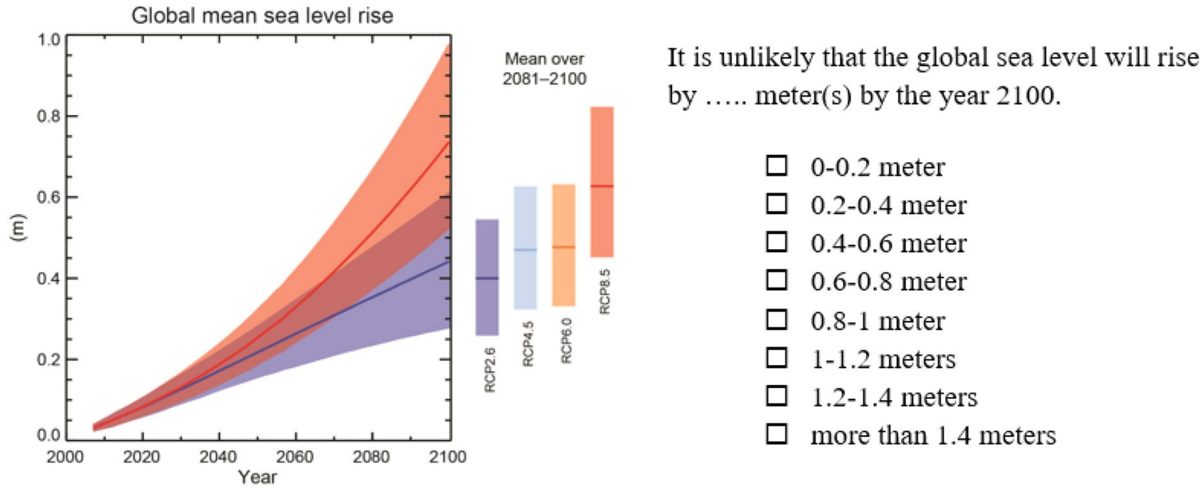
Additional information
Extended data is available for this paper at https://doi.org/10.1038/s41558-025-02472-1.

Supplementary information The online version contains supplementary material available at https://doi.org/10.1038/s41558-025-02472-1.

Correspondence and requests for materials should be addressed to Marie Juanchich.

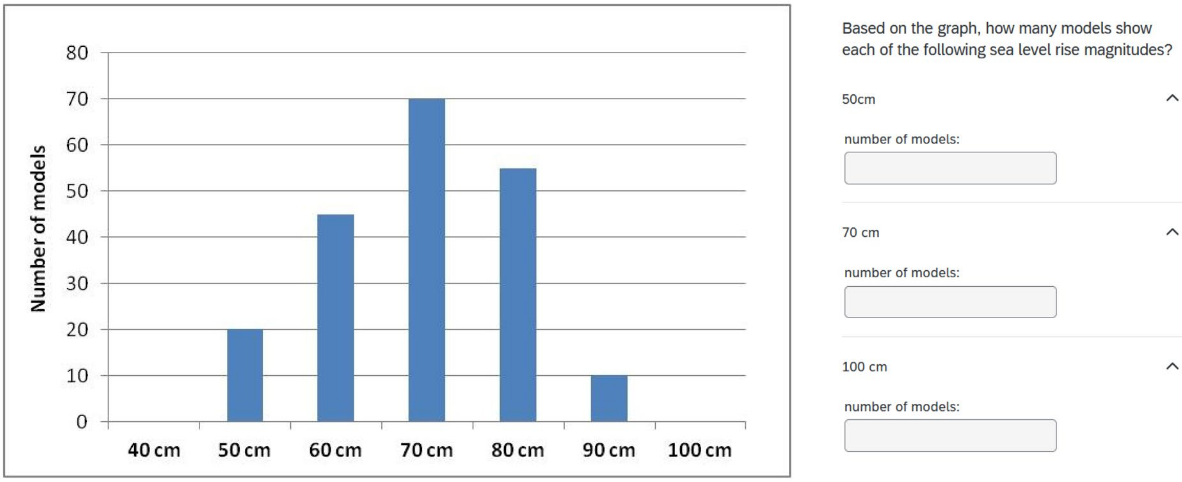
Peer review information *Nature Climate Change* thanks the anonymous reviewers for their contribution to the peer review of this work.

https://doi.org/10.1038/s41558-025-02472-1



Extended Data Fig. 1 | Outcome selection task used in Experiment 1. The figure shows on the left-hand side the projected sea level rise IPCC Figure SPM.9 (ref. 10), and on the right-hand side an example of probabilistic sentence to be completed based on the plot (the verbal probability varied between-subjects). The sea level rise plot shows "global mean sea level rise from 2006 to 2100 as determined by multi-model simulations. All changes are relative to 1986–2005. Time series of projections and a measure of uncertainty (shading) are shown for scenarios RCP2.6 (blue) and RCP8.5 (red). The mean and associated uncertainties averaged over 2081–2100 are given for all RCP scenarios as coloured vertical bars at the right hand side of each panel. The number of Coupled Model Intercomparison Project Phase 5 (CMIP5) models used to calculate the multi-model mean is indicated" (page 26 (ref. 10)).

https://doi.org/10.1038/s41558-025-02472-1



Extended Data Fig. 2 | Sea level rise plot used in the outcome selection task in Experiment 2 with associated graph comprehension questions. Participants used the sea level rise distribution shown on the left to complete a probability statement in the outcome selection task (it is unlikely [there is a small possibility] that the sea level will rise … cm). Participants also answered the three questions shown on the right which assessed their understanding of the graph.

nature portfolio

Corresponding author(s): Marie Juanchich

Last updated by author(s): Marie Juanchich

Reporting Summary

Nature Portfolio wishes to improve the reproducibility of the work that we publish. This form provides structure for consistency and transparency in reporting. For further information on Nature Portfolio policies, see our Editorial Policies and the Editorial Policy Checklist.

Please do not complete any field with "not applicable" or n/a. Refer to the help text for what text to use if an item is not relevant to your study.
For final submission: please carefully check your responses for accuracy; you will not be able to make changes later.

Statistics

For all statistical analyses, confirm that the following items are present in the figure legend, table legend, main text, or Methods section.

n/a	Confirmed	
☐	☑	The exact sample size (*n*) for each experimental group/condition, given as a discrete number and unit of measurement
☐	☑	A statement on whether measurements were taken from distinct samples or whether the same sample was measured repeatedly
☐	☑	The statistical test(s) used AND whether they are one- or two-sided *Only common tests should be described solely by name; describe more complex techniques in the Methods section.*
☐	☑	A description of all covariates tested
☐	☑	A description of any assumptions or corrections, such as tests of normality and adjustment for multiple comparisons
☐	☑	A full description of the statistical parameters including central tendency (e.g. means) or other basic estimates (e.g. regression coefficient) AND variation (e.g. standard deviation) or associated estimates of uncertainty (e.g. confidence intervals)
☐	☑	For null hypothesis testing, the test statistic (e.g. *F*, *t*, *r*) with confidence intervals, effect sizes, degrees of freedom and *P* value noted *Give P values as exact values whenever suitable.*
☐	☑	For Bayesian analysis, information on the choice of priors and Markov chain Monte Carlo settings
☑	☐	For hierarchical and complex designs, identification of the appropriate level for tests and full reporting of outcomes
☐	☑	Estimates of effect sizes (e.g. Cohen's *d*, Pearson's *r*), indicating how they were calculated

Our web collection on statistics for biologists contains articles on many of the points above.

Software and code

Policy information about availability of computer code

Data collection	Online survey using Qualtrics
Data analysis	SPSS 27 for the analyses and Python 3.6.6 for the figures (seaborn package)

For manuscripts utilizing custom algorithms or software that are central to the research but not yet described in published literature, software must be made available to editors and reviewers. We strongly encourage code deposition in a community repository (e.g. GitHub). See the Nature Portfolio guidelines for submitting code & software for further information.

Data

Policy information about availability of data

All manuscripts must include a data availability statement. This statement should provide the following information, where applicable:
- Accession codes, unique identifiers, or web links for publicly available datasets
- A description of any restrictions on data availability
- For clinical datasets or third party data, please ensure that the statement adheres to our policy

Data are available on the Open Science Framework: https://osf.io/ch4wf/

Research involving human participants, their data, or biological material

Policy information about studies with human participants or human data. See also policy information about sex, gender (identity/presentation), and sexual orientation and race, ethnicity and racism.

Reporting on sex and gender	We report participants' gender
Reporting on race, ethnicity, or other socially relevant groupings	✓
Population characteristics	We report participants age, gender, ethnicity, education and language proficiency levels.
Recruitment	Participants were recruited via the online platform Prolific.
Ethics oversight	Ethics board of the University of Essex

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Field-specific reporting

Please select the one below that is the best fit for your research. If you are not sure, read the appropriate sections before making your selection.

☐ Life sciences ☑ Behavioural & social sciences ☐ Ecological, evolutionary & environmental sciences

For a reference copy of the document with all sections, see nature.com/documents/nr-reporting-summary-flat.pdf

Life sciences study design

All studies must disclose on these points even when the disclosure is negative.

Sample size	
Data exclusions	
Replication	
Randomization	
Blinding	

Behavioural & social sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	We report data from eight quantitative experiments
Research sample	The samples across experiments are fully described in the Method section,
Sampling strategy	We used quota sampling for gender across experiments. Three experiments also involve quota for age and ethnicity of political orientation.
Data collection	We used an online survey to gather participants' responses. The survey was designed using Qualtrics.
Timing	Data collection took place between July 2023 and January 2025
Data exclusions	Data exclusion are reported in full
Non-participation	No participants dropped out after consenting to complete the study.
Randomization	Participants were randomly allocated to experimental conditions using the Qualtrics randomiser.

Ecological, evolutionary & environmental sciences study design

All studies must disclose on these points even when the disclosure is negative.

Study description	
Research sample	
Sampling strategy	
Data collection	
Timing and spatial scale	
Data exclusions	
Reproducibility	
Randomization	
Blinding	

Did the study involve field work? ☐ Yes ☐ No

Field work, collection and transport

Field conditions	
Location	
Access & import/export	
Disturbance	

Reporting for specific materials, systems and methods

We require information from authors about some types of materials, experimental systems and methods used in many studies. Here, indicate whether each material, system or method listed is relevant to your study. If you are not sure if a list item applies to your research, read the appropriate section before selecting a response.

Materials & experimental systems

n/a	Involved in the study	
☐	☐	Antibodies
☐	☐	Eukaryotic cell lines
☐	☐	Palaeontology and archaeology
☐	☐	Animals and other organisms
☐	☐	Clinical data
☐	☐	Dual use research of concern
☐	☐	Plants

Methods

n/a	Involved in the study	
☐	☐	ChIP-seq
☐	☐	Flow cytometry
☐	☐	MRI-based neuroimaging

Antibodies

Antibodies used	
Validation	

Eukaryotic cell lines

Policy information about cell lines and Sex and Gender in Research

Cell line source(s)	
Authentication	
Mycoplasma contamination	
Commonly misidentified lines (See ICLAC register)	

Palaeontology and Archaeology

Specimen provenance	
Specimen deposition	
Dating methods	

☐ Tick this box to confirm that the raw and calibrated dates are available in the paper or in Supplementary Information.

Ethics oversight	

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Animals and other research organisms

Policy information about studies involving animals; ARRIVE guidelines recommended for reporting animal research, and Sex and Gender in Research

Laboratory animals	
Wild animals	
Reporting on sex	
Field-collected samples	
Ethics oversight	

Note that full information on the approval of the study protocol must also be provided in the manuscript.

Clinical data

Policy information about clinical studies
All manuscripts should comply with the ICMJE guidelines for publication of clinical research and a completed CONSORT checklist must be included with all submissions.

Clinical trial registration	
Study protocol	
Data collection	
Outcomes	

Dual use research of concern

Policy information about dual use research of concern

Hazards

Could the accidental, deliberate or reckless misuse of agents or technologies generated in the work, or the application of information presented in the manuscript, pose a threat to:

No	Yes	
☑	☐	Public health
☑	☐	National security
☑	☐	Crops and/or livestock
☑	☐	Ecosystems
☑	☐	Any other significant area

Experiments of concern

Does the work involve any of these experiments of concern:

No	Yes	
☑	☐	Demonstrate how to render a vaccine ineffective
☑	☐	Confer resistance to therapeutically useful antibiotics or antiviral agents
☑	☐	Enhance the virulence of a pathogen or render a nonpathogen virulent
☑	☐	Increase transmissibility of a pathogen
☑	☐	Alter the host range of a pathogen
☑	☐	Enable evasion of diagnostic/detection modalities
☑	☐	Enable the weaponization of a biological agent or toxin
☑	☐	Any other potentially harmful combination of experiments and agents

Plants

Seed stocks

Novel plant genotypes

Authentication

ChIP-seq

Data deposition

☐ Confirm that both raw and final processed data have been deposited in a public database such as GEO.

☐ Confirm that you have deposited or provided access to graph files (e.g. BED files) for the called peaks.

Data access links
May remain private before publication.

Files in database submission

Genome browser session
(e.g. UCSC)

Methodology

Replicates

Sequencing depth

Antibodies

Peak calling parameters

Data quality

Software

Flow Cytometry

Plots

Confirm that:

- [ ] The axis labels state the marker and fluorochrome used (e.g. CD4-FITC).
- [ ] The axis scales are clearly visible. Include numbers along axes only for bottom left plot of group (a 'group' is an analysis of identical markers).
- [ ] All plots are contour plots with outliers or pseudocolor plots.
- [ ] A numerical value for number of cells or percentage (with statistics) is provided.

Methodology

Sample preparation

Instrument

Software

Cell population abundance

Gating strategy

- [ ] Tick this box to confirm that a figure exemplifying the gating strategy is provided in the Supplementary Information.

Magnetic resonance imaging

Experimental design

Design type

Design specifications

Behavioral performance measures

Imaging type(s)

Field strength

Sequence & imaging parameters

Area of acquisition

Diffusion MRI ☐ Used ☐ Not used

Preprocessing

Preprocessing software

Normalization

Normalization template

Noise and artifact removal

Volume censoring

Statistical modeling & inference

Model type and settings

Effect(s) tested

Specify type of analysis: ☐ Whole brain ☐ ROI-based ☐ Both

Statistic type for inference

(See Eklund et al. 2016)

Correction

Models & analysis

n/a	Involved in the study
☐	☐ Functional and/or effective connectivity
☐	☐ Graph analysis
☐	☐ Multivariate modeling or predictive analysis

Functional and/or effective connectivity

Graph analysis

Multivariate modeling and predictive analysis