

Science Communication

Scientific uncertainty and trust in science

Rui Mata, HS 2026

Version: October 15, 2026

Course structure

Session information

Sessions take place Thursdays, 8.15–9.45, Biozentrum, Hörsaal U1.131.

#	Date	Topic	Instructor(s)	Material	Exercise
1	17.09.2026	What is science communication?	Mata	pdf	
2	08.10.2026	Models and elements of science communication	Mata	pdf	
3	15.10.2026	Scientific uncertainty and trust in science	Mata	pdf	
4	22.10.2026	Guidelines for science communication	Mata	pdf	
5	29.10.2026	Science communication in practice	Mata	pdf	
6	05.11.2026	Why do we visualize?	Hil/Lachenmeier		
7	12.11.2026	Structured content	Hil/Lachenmeier		A
8	19.11.2026	Content dimensions and categorization	Hil/Lachenmeier		B
9	26.11.2026	The identity of a dot	Hil/Lachenmeier		C
10	03.12.2026	Networks and relationships	Hil/Lachenmeier		D
11	10.12.2026	Visual language and cultural context & Areas and hierarchies	Hil/Lachenmeier		E
12	17.12.2026	Exam			

Goals for today

- Discuss the importance of trust in science, understand the measurement of trust in science, and become familiar with overall trends in trust in science
- Become familiar with the concept of scientific evidence and be able to distinguish different levels/quality of evidence
- Become familiar with the concept of uncertainty, be able to distinguish different types of uncertainty, and become familiar with several factors influencing the role of uncertainty on communication

Conflicting evidence and trust in science

March 2020

 World Health Organization (WHO) 
@WHO

FACT: #COVID19 is NOT airborne.

The #coronavirus is mainly transmitted through droplets generated when an infected person coughs, sneezes or speaks.

To protect yourself:

- keep 1m distance from others
- disinfect surfaces frequently
- wash/rub your 🙌
- avoid touching your 👁️👃👄

[Traduzir post](#)

FACT CHECK: COVID-19 is NOT airborne

The virus that causes COVID-19 is mainly transmitted through droplets generated when an infected person coughs, sneezes, or speaks. **These droplets are too heavy to hang in the air. They quickly fall on floors or surfaces.**

You can be infected by breathing in the virus if you are within 1 metre of a person who has COVID-19, or by touching a contaminated surface and then touching your eyes, nose or mouth before washing your hands.

To protect yourself, keep at least 1 metre distance from others and disinfect surfaces that are touched frequently. Regularly clean your hands thoroughly and avoid touching your eyes, mouth, and nose.

 World Health Organization
March 28 2020
#Coronavirus #COVID19

 PAHO/WHO e mais 6

11:44 AM · 28 de mar de 2020

December 2021

23 December

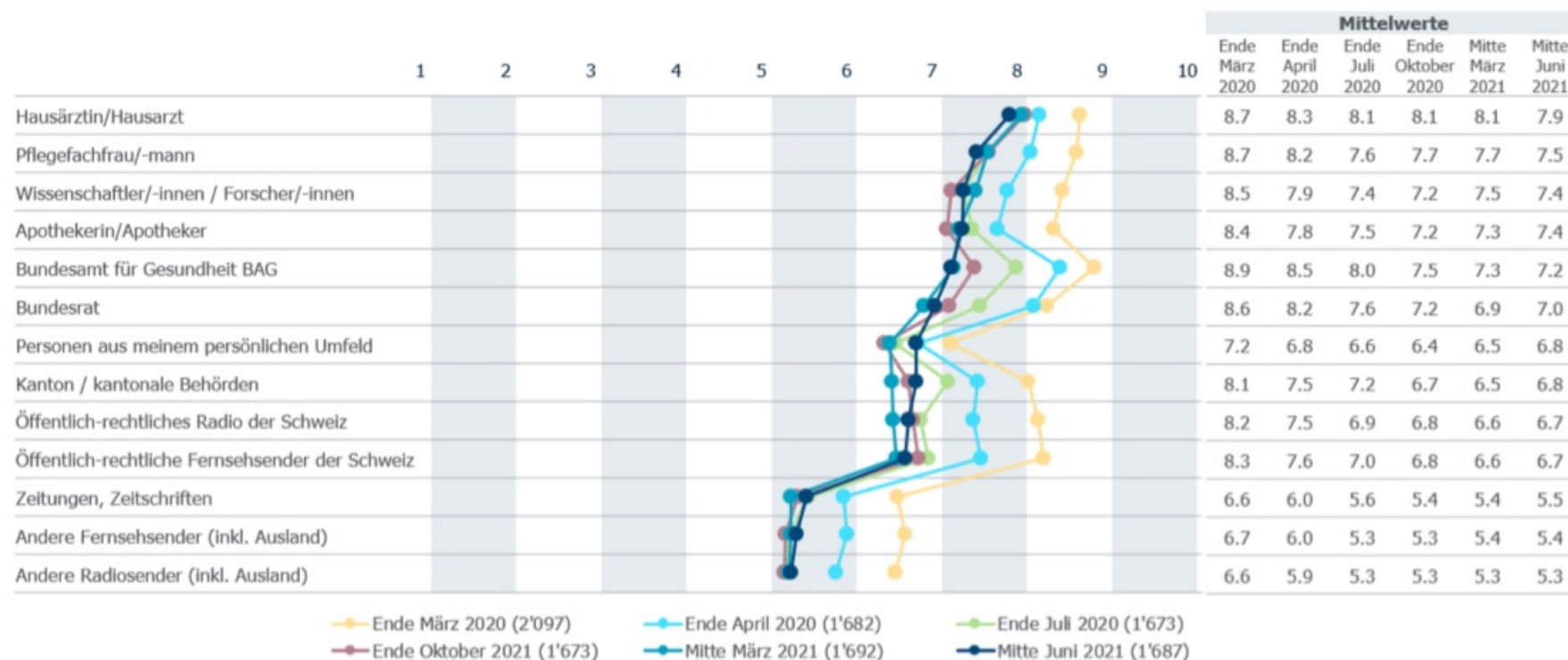
"Current evidence suggests that the virus spreads mainly between people who are in close contact with each other, for example at a conversational distance ...

The virus can also spread in poorly ventilated and/or crowded indoor settings, where people tend to spend longer periods of time. This is because aerosols can remain suspended in the air or travel farther than conversational distance (this is often called long-range aerosol or long-range airborne transmission)."

Nearly two years into the pandemic, the WHO uses the term 'airborne' for the first time.

Lewis D. (2022). Why the WHO took two years to say COVID is airborne. *Nature*, 604(7904), 26-31.

Abb. 21 Wie hoch ist Ihr Vertrauen in folgende Organisationen und Personengruppen hinsichtlich Informationen zum Coronavirus?



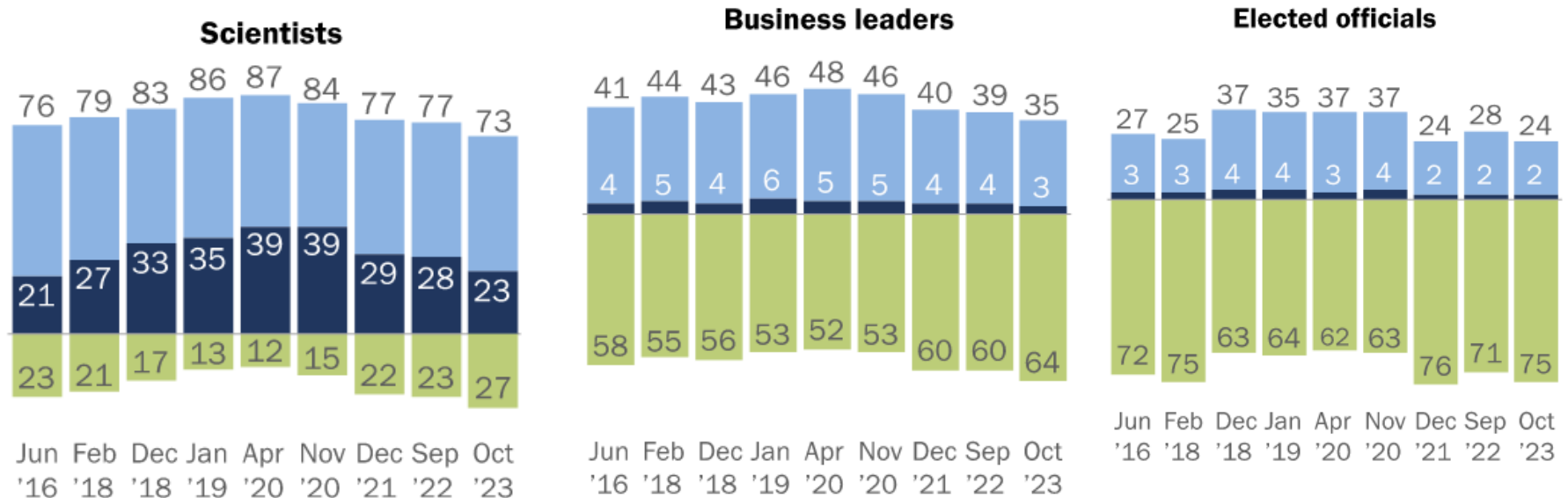
Basis: Anzahl Befragte in Klammern / Skala von «1» (= «Sehr geringes Vertrauen») bis «10» (= «Sehr hohes Vertrauen»)

Trends in trust in science

Majorities of Americans say they have at least a fair amount of confidence in scientists, but ratings have fallen since early in the coronavirus outbreak

% of U.S. adults who have ___ of confidence in the following groups to act in the best interests of the public

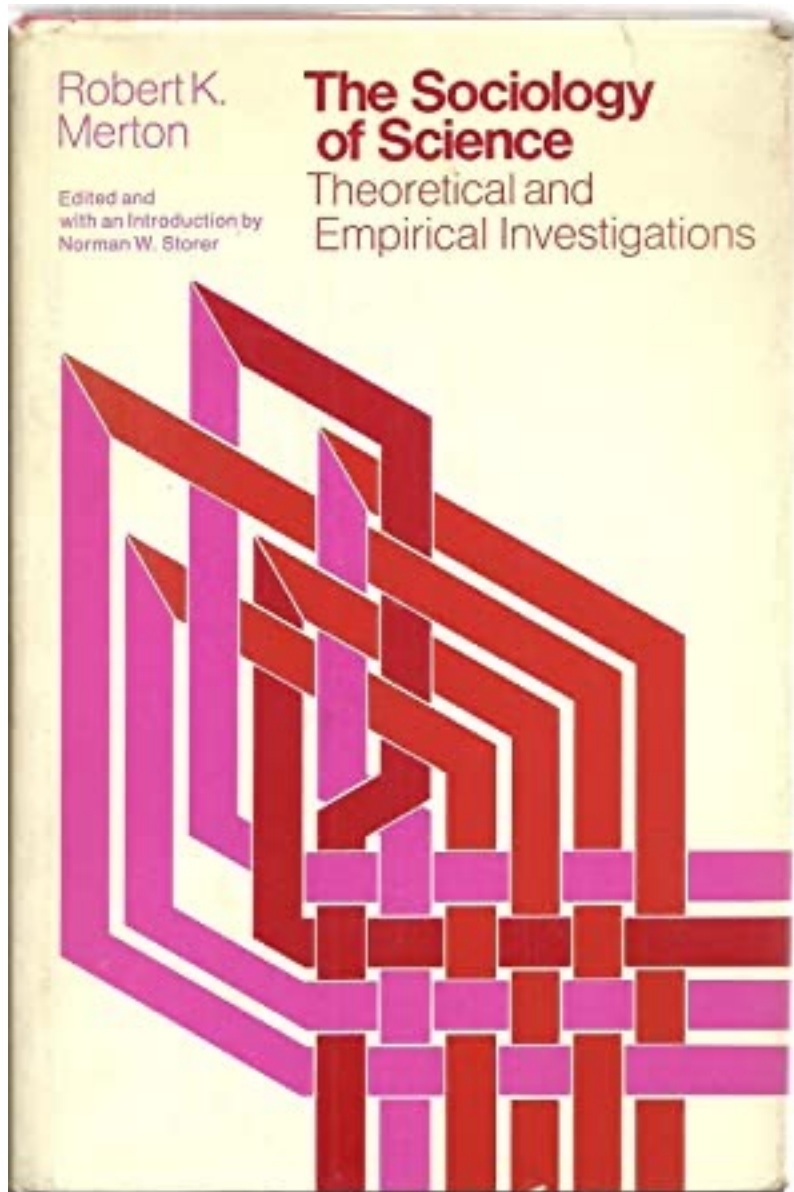
● A great deal ● A fair amount ● Not too much/No confidence at all



Lupia, A., Allison, D. B., Jamieson, K. H., Heimberg, J., Skipper, M., & Wolf, S. M. (2024). Trends in US public confidence in science and opportunities for progress. *Proceedings of the National Academy of Sciences*, 121(11), e2319488121. <https://doi.org/10.1073/pnas.2319488121>

WHY TRUST SCIENCE? AND SCIENTISTS?





The Ethos of Science (aka, the Mertonian norms):

- Universalism: it's not about who is doing the science
- Communism/Communality: scientists share!
- Disinterestedness: scientists don't have egos or financial interests, only thirst for knowledge
- Organized skepticism: no claim is accepted at face value...

WHY TRUST SCIENCE ? NAOMI ORESKE

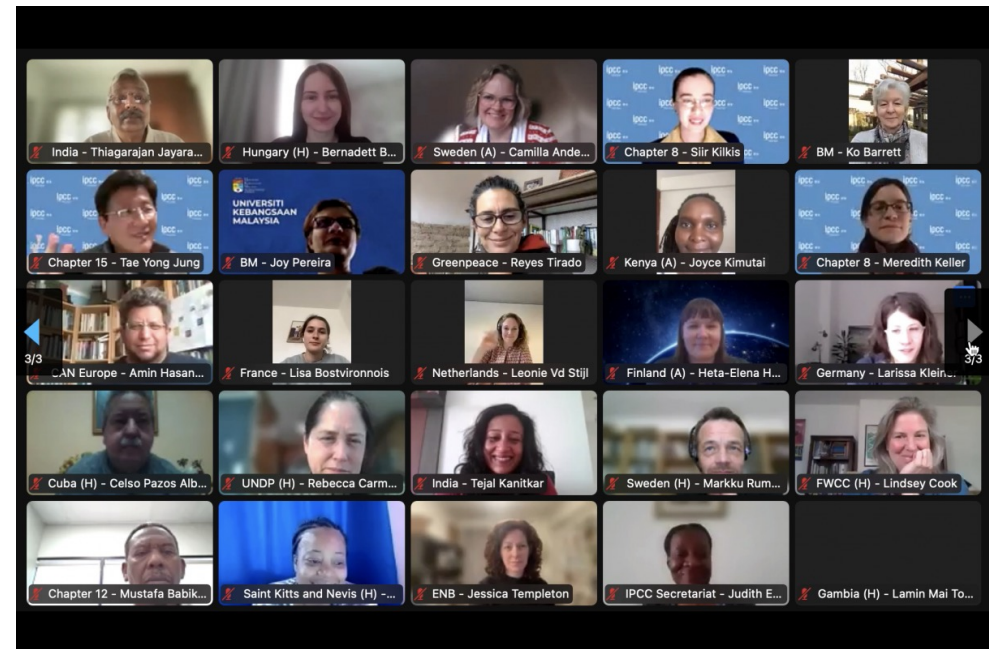
Trust in science is **not** warranted because there is a singular scientific method that is objective and infallible; science consists of communities of people, making decisions for reasons that are both altruistic and self-interested, using diverse methods.

There are however some reasons to **trust** science, specifically:

- its sustained engagement with testable empirical phenomena;
- its social and organized character – a form of **organized skepticism** that tends to self-correction in the long run.

ipcc

INTERGOVERNMENTAL PANEL ON
climate change



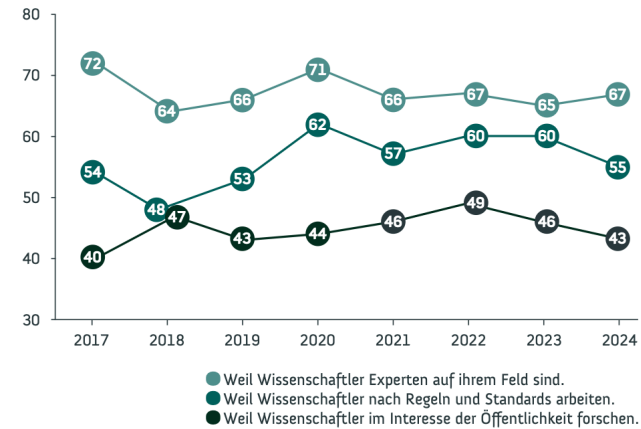
<https://www.ipcc.ch>

How is trust measured?

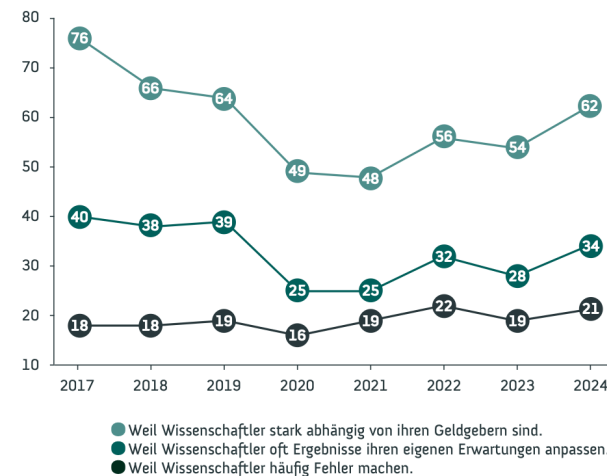
“The results show that surveys rarely measure distrust in science, and instead focus on trust in science – mainly at the macro-level – rather than trust in scientists (micro-level) or scientific organisations (meso-level). Benevolence is the dimension of trust considered most frequently; the media is predominantly included as a general type of contact with science without a direct link to (dis)trust. Hence, representative surveys cover a number of different aspects of public (dis)trust in science. However, there is room for improvement.”

Trust and distrust can be measured in different ways, and people can have several reasons for both. Someone may trust scientists' expertise while questioning their independence or motives. Understanding public trust may require asking not only **how much people trust, but whom they trust, and why.**

Zustimmung zu verschiedenen Gründen, Wissenschaftlern zu vertrauen



Zustimmung zu verschiedenen Gründen, Wissenschaftlern zu misstrauen



<https://wissenschaft-im-dialog.de>

Reif, A., & Guenther, L. (2021). How representative surveys measure public (dis)trust in science: A systematisation and analysis of survey items and open-ended questions. *Journal of Trust Research*, 11(2), 94–118. <https://doi.org/10.1080/21515581.2022.2075373>

WHAT IS SCIENTIFIC EVIDENCE?

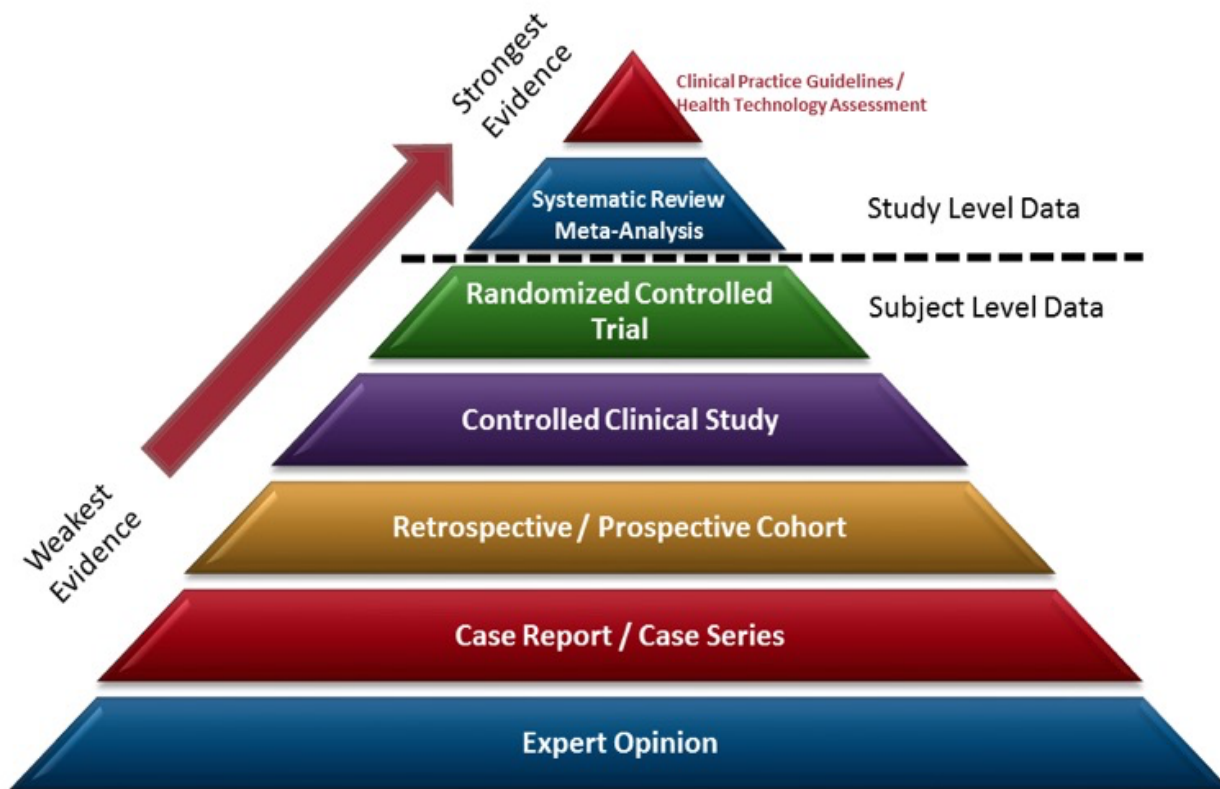
and is all evidence created equal?



Scientific evidence

Scientific evidence refers to **information or data that justifies belief** in a hypothesis or theory by making it reasonable to hold certain conclusions. It serves as a rational guide to truth by providing a reliable basis for distinguishing between true and false claims. Scientific evidence is often empirical, arising from observation or experimentation, and is used to confirm or disconfirm theories. Scientific evidence can be seen as a neutral arbiter in resolving theoretical disputes, and it is expected to be objective, public, and intersubjective, meaning that it can be assessed and confirmed by others, leading to consensus.

Levels of evidence



https://en.wikipedia.org/wiki/Hierarchy_of_evidence

Levels of evidence

GRADE (Grading of Recommendations, Assessment, Development, and Evaluations)

Table 5.1: Quality of Evidence Grades	
Grade	Definition
High	We are very confident that the true effect lies close to that of the estimate of the effect.
Moderate	We are moderately confident in the effect estimate: The true effect is likely to be close to the estimate of the effect, but there is a possibility that it is substantially different
Low	Our confidence in the effect estimate is limited: The true effect may be substantially different from the estimate of the effect.
Very Low	We have very little confidence in the effect estimate: The true effect is likely to be substantially different from the estimate of effect

Quality of evidence is a continuum; any discrete categorisation involves some degree of arbitrariness. Nevertheless, advantages of simplicity, transparency, and vividness outweigh these limitations.

GRADE provides a structured, transparent way to assess certainty in evidence. Its four categories simplify a continuum, and ratings still depend on expert judgment so the reasoning behind a grade matters as much as the label.

SUMMARY POINTS

A guideline's formulation should include a clear question with specification of all outcomes of importance to patients

GRADE offers four levels of evidence quality: high, moderate, low, and very low

Randomised trials begin as high quality evidence and observational studies as low quality evidence

Quality may be downgraded as a result of limitations in study design or implementation, imprecision of estimates (wide confidence intervals), variability in results, indirectness of evidence, or publication bias

Quality may be upgraded because of a very large magnitude of effect, a dose-response gradient, and if all plausible biases would reduce an apparent treatment effect

Critical outcomes determine the overall quality of evidence

Evidence profiles provide simple, transparent summaries

Guyatt, G. H., Oxman, A. D., Kunz, R., Vist, G. E., Falck-Ytter, Y., & Schünemann, H. J. (2008). What is "quality of evidence" and why is it important to clinicians? *BMJ*, 336(7651), 995–998.

<https://doi.org/10.1136/bmj.39490.551019.BE>

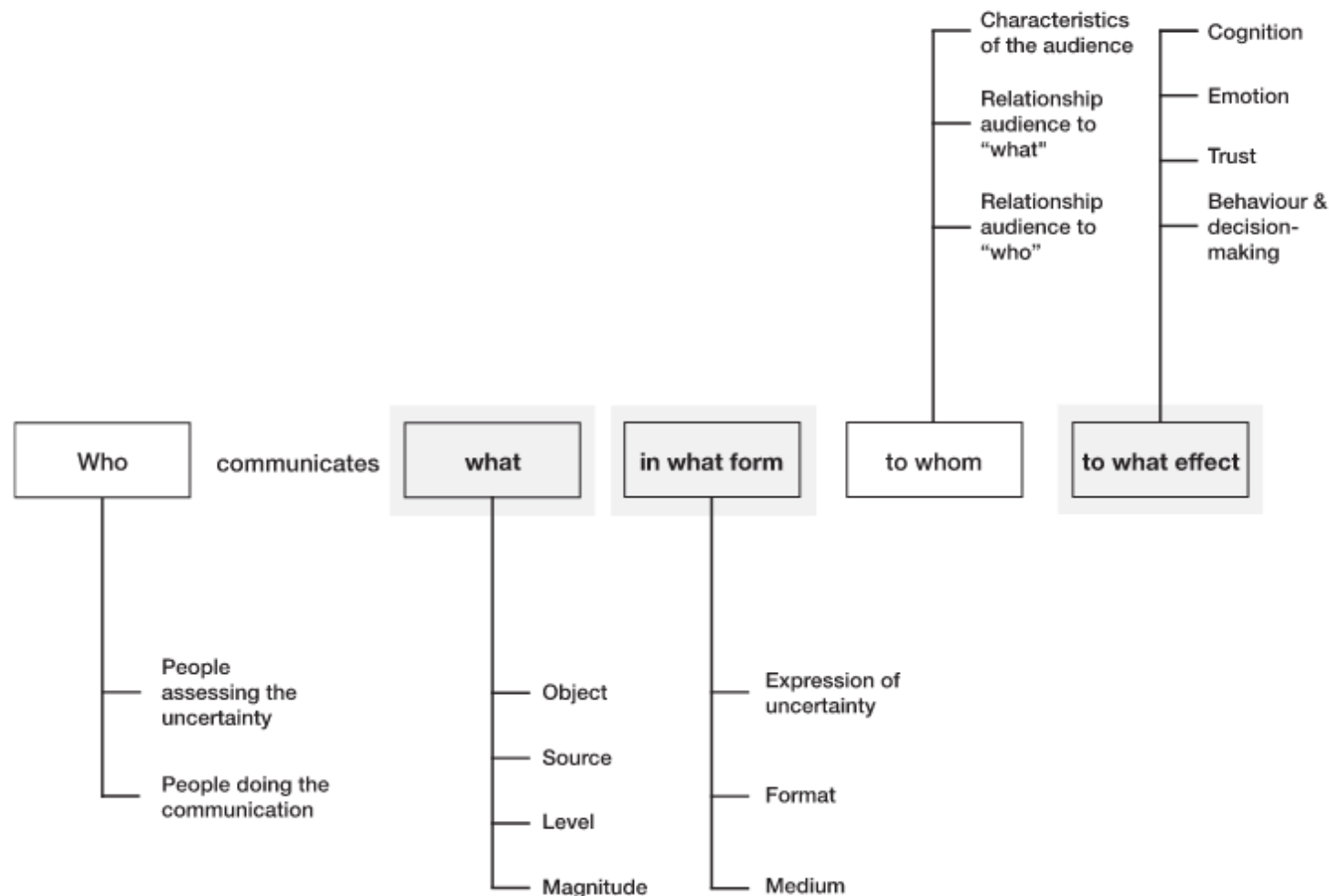
WHAT IS SCIENTIFIC UNCERTAINTY?



Types of (scientific) uncertainty

Uncertainty	Description	Examples
Aleatory	Refers to uncertainty due to fundamental indeterminacy or randomness in the world. Often associated with unpredictable future events, luck, or chance.	Communicating the inherent unpredictability of future events like economic forecasts or climate change models
Epistemic	Refers to uncertainty due to limited knowledge or ignorance, often concerning past or present phenomena that could potentially be known with more data.	Reporting uncertainty in scientific estimates, e.g., “The current estimate for the number of tigers in India ranges from 2,500 to 3,000 due to sampling error.”

A framework for communicating uncertainty



van der Bles, A. M., van der Linden, S., Freeman, A. L. J., Mitchell, J., Galvao, A. B., Zaval, L., & Spiegelhalter, D. J. (2019). Communicating uncertainty about facts, numbers and science. Royal Society Open Science, 6(5), 181870. <https://doi.org/10.1098/rsos.181870>

A framework for communicating uncertainty

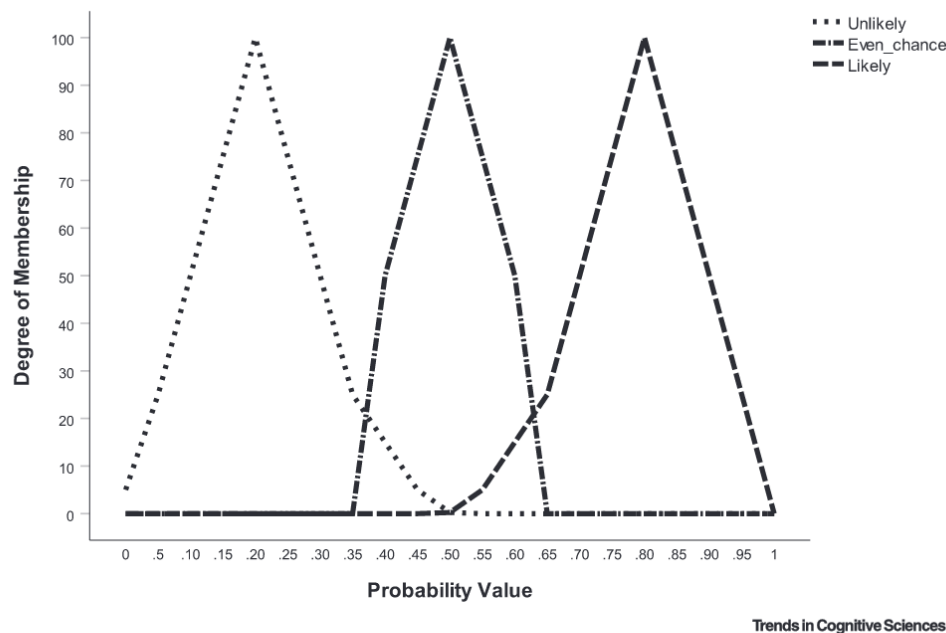


Figure 1. Hypothetical membership functions for three probability terms. Participants are asked to determine how well they think each numeric probability value (e.g., 0, 0.5, 0.10,...1) represents a specific term (e.g., *likely*). Responses are provided by marking a point on a scale (from 0 to 100) for each probability value. This yields several measures, such as the 'minimum', 'maximum', and 'peak' numeric values that the term represents, as well as the 'spread' (i.e., maximum minus the minimum) of values.

Highlights

The (positive and negative) directionality of verbal probabilities enables them to convey more than uncertainty. Probability terms can communicate uncertainty in a face-saving manner and implicitly shape receivers' cognitions and behavior.

Verbal probabilities preclude fine-grained uncertainty communication. Assigning numeric probability ranges to words does not eliminate their imprecise and variable meaning, but can have unintended effects on judgment and decision-making.

Senders are misplaced in their belief that verbal expressions of uncertainty are especially helpful for those with lower numeracy and in thinking that these individuals cannot benefit from numeric probability information.

The benefits of precise numeric expressions of uncertainty, coupled with receivers' preference for numeric information when it really matters, suggests that senders ought to embrace numeric precision over vague words if they wish to communicate uncertainty clearly.

A framework for communicating uncertainty

Uncertainty	Meaning	Example
Deficient	Identifiable gaps or limitations in current knowledge—“known unknowns.”	“We have only six months of follow-up, so we don’t know the long-term effects.”
Technical	Quantified imprecision arising from measurement, modelling or statistical estimation.	“The estimated effect is 10%, with a confidence interval of 6–14%.”
Scientific	The inherent provisionality of scientific knowledge.	“This is our best current understanding, but future discoveries could revise it.”
Consensus	Disagreement among experts or conflicting findings within the evidence.	“Studies disagree about whether the treatment is effective.”

“Uncertainty is inherent to science and science communication. However, the evidence appears mixed regarding whether portraying uncertainty in science communication has positive or negative effects. We review a diverse range of experimental literature ($k = 48$), summarize the extant findings, and observe how the effects vary across four different types of communicated uncertainty (deficient, technical, scientific, and consensus uncertainty). The results indicate that most findings of negative effects (such as reduced credibility and beliefs) are from experiments that operationalized uncertainty as disagreement or conflict in science (consensus uncertainty). In this review, consensus uncertainty was never found to have positive effects. In contrast, uncertainty in the form of quantified error ranges and probabilities (technical uncertainty) in these studies has had only positive or null effects, not negative effects.”

Communicating uncertainty need not undermine credibility. Its effects depend on the type of uncertainty conveyed: portraying disagreement among experts or conflicting evidence is more likely to have negative effects.

Summary

- **Trust:** Trust in science is based on its empirical nature and its social, organized structure, which fosters self-correction through skepticism and peer review. The Mertonian norms (universalism, communalism, disinterestedness, organized skepticism) remain key in ensuring that scientific knowledge is shared openly, subjected to critical review, leading to trust. Surveys measuring public trust in science often focus on the macro-level (trust in science as a whole) but overlook micro-level (individual scientists) and meso-level (scientific institutions) aspects. Overall trust in science and scientists is high and remains so, however, there have been recent changes probably also due to science communication difficulties.
- **Scientific Evidence:** Scientific evidence serves as a guide to distinguish true from false claims, and is typically empirical, arising from observation or experimentation. Ideally, evidence is objective, public, and intersubjective, allowing consensus building. Different levels of evidence exist, with a hierarchy from expert opinion to systematic reviews and meta-analyses.
- **Uncertainty:** aleatory uncertainty refers to randomness or unpredictability in the world (e.g., forecasts), epistemic uncertainty arises from limited knowledge or incomplete data (e.g., sampling errors in population estimates); Effective communication of uncertainty involves expressing it clearly, either through direct expressions (quantifiable measures like confidence intervals or verbal likelihoods), or indirect expressions (quality of evidence, such as subjective confidence in a claim).