

Making Your Audience Ignorant: Simplification and Accuracy in the Presentation of Scientific Results

Corey Dethier

Leibniz Universität Hannover
Philosophy Department
corey.dethier@gmail.com

July 4, 2022

The talk

When is it appropriate for an expert to provide false or misleading information?

The plan:

- 1 Motivating the question: the IPCC.
- 2 An illustrative example: Newton's second law.
- 3 Generalizing the example.
- 4 Returning to the IPCC.

Motivation

The IPCC's presentation of uncertainty

The IPCC generally avoids precise / quantitative probabilities in their reports.

Equilibrium climate sensitivity is likely in the range 1.5°C to 4.5°C (high confidence), extremely unlikely less than 1°C (high confidence), and very unlikely greater than 6°C (medium confidence). (IPCC 2013, 16)

Philosophers on uncertainty in climate science

Probabilities are inappropriate for “expressing our current knowledge about climate change.” (Betz 2007, 2)

“Though [precise probabilities] may be desirable, further reflection may reveal that the requirements [on their justified use] can rarely be met when it comes to the predictions of greatest interest to decision makers.” (Parker 2011, 996)

Precise probabilities “should not be used in the climate context.” (Katzav et al. 2021, 2)

Why not?

Because scientists / experts should only present information that they *know* to be accurate, and in climate science, we don't know that the precise probabilities are accurate.

Inevitability

When communicating from a position of expertise, approximations and idealizations are inevitable.

This means that it's inevitable that the communication will present the audience with information that is false or misleading.

An illustrative example: Newton's second law.

Some presentations of Newton's laws

We know objects can only accelerate if there are forces on the object.

Newton's second law tells us exactly how much an object will accelerate for a given net force.

$$a = \frac{\Sigma F}{m}$$

To be clear, a is the acceleration of the object, ΣF is the net force on the object, and m is the mass of the object.

[\[Wait, I thought Newton's second law was \$F=ma\$?\]](#)

- Khan Academy (2022)

Some presentations of Newton's laws

Newton's second law of motion: If a net external force acts on a body, the body accelerates. The direction of acceleration is the same as the direction of the net force. The mass of the body times the acceleration of the body equals the net force vector.

In symbols,

$$\sum \vec{F} = m\vec{a} \quad (\text{Newton's second law of motion}) \quad (4.7)$$

- Young, Freedman, and Ford (2008, 117)

What Newton actually says

“A change in motion is proportional to the motive force impressed and takes place along the straight line in which that force is impressed.”

- Newton (1727/1999, 416)

Whence $F = ma$?

DECOUVERTE
D'UN NOUVEAU PRINCIPE DE MECANIQUE,
PAR M. EULER.

Three principles: $F_x = ma_x$, $F_y = ma_y$, $F_z = ma_z$.

- Euler (1752, 196)

Historical views

Pourciau: “Principia’s second law” is that the deflection generated by force F is the same regardless of whether the body being acted upon is moving or at rest. (Pourciau 2006)

The point, part 1

Equating “Newton’s second law” and $F = ma$ is false or at least misleading.

Leads the audience to be ignorant:

- ① of Newton’s actual second law.
- ② of post-Newton debates about the foundations of physics.
- ③ of Euler’s contribution to mechanics.
- ④ of the practice of revising and reformulating scientific laws.

The point, part 2

Nevertheless, simplification in this case seems both inevitable and worthwhile.

Equating “Newton’s second law” and $F = ma$ is useful for efficiently teaching the relevant physics.

(Compare Lackey (2007) and McKinnon (2015).)

General conclusions

Main takeaway

Whether an expert should present inaccurate (simplified, idealized, approximate) information depends on their particular communicative goals and context.

Main takeaway

Whether an expert should present inaccurate (simplified, idealized, approximate) information depends on their particular communicative goals and context.

What parts of an expert's testimony should be inaccurate (simplified, idealized, approximate) depends on their particular communicative goals and context.

Not *always* good to mislead

Structurally similar example:

While the peacock flower itself moved easily into Europe, the knowledge of its use as an abortifacient did not. ... If [Caspar Commelin] and others had valued knowledge of how to manage women's fertility, knowledge of the peacock flower and its uses would have quickly spread throughout Europe. But it did not. (Schiebinger 2008, 151)

The role of experts

Even when everything is going right, experts have to choose where to present accurate information and where to mislead by simplifying or remaining silent.

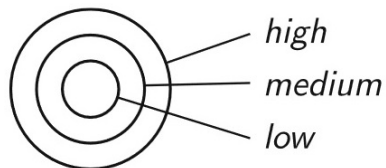
It isn't enough to point out that a claim is (in)accurate w.r.t. a particular target; the question is whether accuracy towards that target is something the expert should be prioritizing.

The IPCC and accurately representing uncertainty.

The IPCC's presentation of uncertainty

“Equilibrium climate sensitivity is likely in the range 1.5°C to 4.5°C (high confidence), extremely unlikely less than 1°C (high confidence), and very unlikely greater than 6°C (medium confidence).” (IPCC 2013, 16)

Interpreting the IPCC



- Helgeson, Bradley, and Hill
(2018)

Each circle represents a set of probability functions. “[ECS] is likely in the range 1.5°C to 4.5°C (high confidence)” means that all of the probability functions in the “high confidence” group assign at least .66 probability to $1.5^{\circ}\text{C} < \text{ECS} < 4.5^{\circ}\text{C}$.

The point, part 1

Right now, the IPCC preserves accuracy w.r.t. uncertainty at the cost of a more complex (and thus hard-to-understand) representation.

This is a *choice*, and we need to ask whether this choice of what to accurately present is a good one.

-  [Betz, Gregor \(2007\). Probabilities in Climate Policy Advice: A Critical Comment. *Climatic Change* 85.1-2: 1–9.](#)
-  [Euler, Leonhard \(1752\). Descouverte d'un Nouveau Principe de Mechanique. *Mémoires de l'académie des sciences de Berlin* 6: 185–217.](#)
-  [Helgeson, Casey, Richard Bradley, and Brian Hill \(2018\). Combining Probability with Qualitative Degree-of-Certainty Metrics in Assessment. *Climatic Change* 149.3: 517–25.](#)
-  [IPCC \(2013\). *Climate Change 2013: The Physical Science Basis*. Ed. by Thomas F. Stocker et al. Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge: Cambridge University Press.](#)
-  [Katzav, Joel et al. \(2021\). On the Appropriate and Inappropriate Uses of Probability Distributions in Climate Projections, and Some Alternatives. *Climatic Change* 169.15: 1–20.](#)



Khan Academy (2022). *Newton's Laws*. URL: <https://www.khanacademy.org/science/physics/forces-newtons-laws>.



Lackey, Jennifer (2007). Norms of Assertion. *Noûs* 41.4: 594–626.



McKinnon, Rachel (2015). *The Norms of Assertion: Truth, Lies, and Warrant*. New York: Palgrave Macmillan.



Newton, Isaac (1727/1999). *Mathematical Principles of Natural Philosophy*. Trans. by I. Bernard Cohen and Anne Whitman. 3rd edition. Berkeley: University of California Press.



Parker, Wendy S. (2011). When Climate Models Agree: The Significance of Robust Model Predictions. *Philosophy of Science* 78.4: 579–600.



Pourciau, Bruce (2006). Newton's Interpretation of Newton's Second Law. *Archive for the History of the Exact Sciences* 60.2: 157–207.

-  Schiebinger, Londa (2008). West Indian Abortifacients and the Making of Ignorance. In: *Agnotology: The Making and Unmaking of Ignorance*. Ed. by Robert N. Proctor and Londa Schiebinger. Stanford: Stanford University Press: 149–62.
-  Young, Hugh D., Roger A. Freedman, and Lewis Ford (2008). *University Physics with Modern Physics*. San Francisco: Pearson.