PLEASE READ ALL 'COMMENT' TEXT BEFORE PREPARING YOUR ARTICLE. If you do not see the Comments, select View > Print Layout. Please delete them before submitting (Review > Delete All Comments in Document) so that peer reviewers see a clean copy of the manuscript.

Remember that you are writing for an interdisciplinary audience. Please be sure to discuss interdisciplinary themes, issues, debates, etc. where appropriate. Note that the WIREs are forums for review articles, rather than primary literature describing the results of original research.

If you have any questions, contact your editorial office.

WIREs Wiley Interdisciplinary Reviews

Article Title: Post-truth and anthropogenic climate change: asking the right questions

Article Type:

○ OPINION	○ PRIMER	○ OVERVIEW
◉ ADVANCED REVIEW	○ FOCUS ARTICLE	○ SOFTWARE FOCUS

Authors:

[**List each person's full name, ORCID iD, affiliation, email address, and any conflicts of interest.** Copy rows as necessary for additional authors. Please use an asterisk (*) to indicate the corresponding author.]

First author Christopher Groves 0000-0002-5873-1119 School of Social Sciences, Cardiff University, Cardiff, UK Grovesc1@cf.ac.uk
Second author [Type information here]

Abstract

The connection between climate scepticism and climate denial and what has become known as post-truth culture has become the subject of much interest in recent years, leading to intense debates among scientists and activists about how to respond to this changed cultural context and the ways in which it is held to obstruct wider acceptance of climate science. Drawing on research in the sociology of scientific knowledge, science and technology studies, social psychology and philosophical reflections on evidential reasoning, it is argued that these debates are focused on the wrong topic. The idea of post-truth implies that a once-straightforward linear relationship between

scientific evidence and decisions on what to do has been eroded. But such an idealised relationship never existed. The proper role of scientific evidence in informing belief and action in response to the prospect of anthropogenic climate change needs reconsideration. A key part of this is to make uncertainties related to processes within the climate system and their potential outcomes into the main focus of public discussion around climate change. Instead of keeping the focus of debate on how to 'get the science right', such a reframing makes precautionary questions about the prospect of unacceptable losses into the main focus, bringing a variety of ethical and political values into the debate, and perhaps creating better conditions for a minimal consensus about what to do.

INTRODUCTION

That policy should be 'evidence based' is a proposition that few with a public voice would disagree with. Scientific evidence is supposed to translate linearly into reasons for us to change our beliefs and then, following on seamlessly, provide reasons for changing what we do, individually and collectively. However, it is generally concluded that the disconnect between the broad scientific consensus on anthropogenic climate change (ACC) and the relative lack of action by governments and populations globally demonstrates that something is wrong with this picture. Often, this is seen as evidence of a broader problem: a distrust of science caused by propagandistic use of scientific results by politicians (Editorial 2018). In recent years, commentators from either side of the political spectrum have appealed to ideals of scientific truth in a bid to draw attention to what has been represented as ideologically-distorted science. In the 1990s, conservative commentators in the USA protested about what they represented as 'junk science' deployed by 'liberal elites' trying to extend government regulation to tackle environmental pollution and ACC. More recently, commentators further to the left have spoken of the dissemination of 'alternative facts' and 'post-truth' culture by the political right in an attempt to divert attention from overwhelming scientific consensus on ACC.

In either case, there is a common assumption at work, namely that there has been, thanks to particular ways of conducting debate over specific issues of public concern, a gradual or sudden deterioration in scientific credibility. Science is no longer receiving due respect. As a result, the supposed straight path from evidence to decision making on policy or, in the case of ACC, wholesale behaviour change, is blocked. On both sides, an appeal to Science with a capital S is made. The Competitive Enterprise Institute's (CEI) challenge to the US National Climate Assessment in 2003 articulated what it saw as the only generally valid scientific method, stating that 'hypotheses must be verified by observed data before they can be regarded as facts' (Horner 2002). By contrast, a recent editorial in *Nature Cell Biology* stated that increasingly non-scientists form 'beliefs based on emotion and isolated personal experience' rather than based on scientific evidence, and that the scientific consensus on ACC being a 'pressing problem' can be contrasted with public attitudes, which 'vary widely' (Editorial 2018). Whether an appeal to idealised method or idealised consensus is made, in either case it is made in response to what is believed to be a betrayal of science by other actors.

Things are not so simple, however. In this commentary on post-truth and ACC, I elaborate on how the sociology of science, psychological understandings of motivated reasoning, and philosophical reflections on the nature of 'public reason' can help us understand why ideas about 'betrayals of science' are too simple, and indeed simplistic. In addition, I suggest that they also demonstrate why

arguing about what science is really telling us is the real problem, rather than this problem being something like a fall from the grace of belief in truth into a debased condition of post-truth.

ACC, UNCERTAINTY AND SCEPTICISM

ACC has been described as an instance of a wicked problem (Rittel and Webber 1973) that crosses boundaries between scientific disciplines and political jurisdictions, or even a super wicked problem (Lazarus 2008), given that governance institutions with a transboundary scope to match the problem's own nature are mostly lacking. Most importantly, it is unprecedented in human experience. There is no observational data which archives previous human experience of human-caused climatic change playing out, along with its consequences for human societies. This places scientific investigation into the phenomenon in a difficult position. Careful curation of many different and often difficult to compare sources of past data on climatic change and its association with greenhouse gases is coupled with the construction of models that simulate events which have not yet happened (Edwards 2010), and which, given the potential consequences of ACC, should actually be prevented from happening. Consequently the idealised observational scientific method appealed to by the CEI has little purchase on the problem. But this is so for much scientific work, where novel phenomena are of interest.

Sidebar title: SCEPTICISM OR DENIAL?

Directly questioning the credibility of climate science takes different forms. It may focus on the evidence climate science provides, or it may focus on aspects of the research process itself. Rahmstorf (2005) introduced an influential distinction between three distinct objects of scepticism and associated claims: *trend scepticism* (there is no increase in global average temperatures), *attribution scepticism* (there is an increase, but it is not humans who are responsible), and *impact scepticism* (there is an increase and humans are responsible, but the impacts will not necessarily be as negative as generally supposed). Scepticism may also be directed at the institutional processes which support research, and make arguments about bias or reliability (Smith and Leiserowitz 2012).

Linking such criticisms to 'denialism' is often done to discredit them (in the same way as 'climate alarmist' or 'warmist' tags are used in the opposite direction), although more generally may imply that a sceptical attitude is seen as rooted in a set of specific beliefs that motivate concerted attempts to discredit scientific evidence, rather than simply reflecting doubts or uncertainties (Whitmarsh 2011). The term carries a moral overtone designed to enforce a distinction not only between stances adopted towards the data, but between identities, and has thus been seen as highly divisive.

There is also, however, a great deal of scope for uncertainty around the ways in which evidence from different disciplines dependent on modelling should be stitched together in order to produce a consensus that can inform policy. Additionally, the possibility of non-linear phenomena like feedback loops within the climate system introduces additional uncertainties. Methodical scepticism about explanations of data is already part of scientific practice. ACC is an example of a phenomenon where such scepticism towards the assumptions behind and results of models is particularly important, as is underlined by ongoing debates among researchers who otherwise agree about ACC regarding elements of the 'consensus position' on the phenomenon (Medhaug et al. 2017), particularly where scientists see scenarios produced as part of the Intergovernmental Panel on Climate Change

reporting process as too conservative (Wynne 2010). However, scepticism has also been positioned within debates on ACC as a problematic phenomenon. Often, doubts about the scientific consensus on ACC from 'unofficial' sources (including bloggers and public commentators) have been associated with denialism, rather than legitimate scepticism, where by denialism is meant 'the employment of rhetorical arguments to give the appearance of legitimate debate where there is none' (Diethelm and McKee 2009, 2). At the same time, commentators may also raise points that scientists view as legitimate and requiring response (Keeling 2018). Lumping together all questioning of what might be represented as consensus positions on ACC as examples of vexatious doubt-mongering motivated by business-as-usual oriented political calculation is therefore illegitimate.

Negotiating the territory of uncertainty upon which debates about ACC are conducted in order to decide what to do is therefore a much more complex undertaking than simply 'accepting the consensus'. Sociology and psychology offer resources for understanding how social actors perform this difficult negotiation. In what follows I take my cue from efforts following earlier debates over the status of science and its alleged misuse by the political right and/or left (e.g. Demeritt 2006) in exploring how this negotiation happens among scientists on the one hand and those to whom they communicate their results on the other, before going on to look at some clues from philosophical resources for deciding how to reframe debates over post-truth and evidence-based policy

BEYOND POST-TRUTH: WHAT IS CREDIBILITY?

It has been argued that the very concept of post-truth involves a distortion, contained in the word 'post' (Jasanoff and Simmet 2017; Kennedy 2017). The idea of truth continues to be a key referent of political discourse, even for the Trump administration (Baker 2017). Public political reasoning, according to the political philosopher John Rawls, is at bottom about determining the basis of social cooperation among people who would otherwise disagree on many matters. This requires reasons for acting collectively that are acceptable to as many as possible, irrespective of substantive (religious, political etc.) values that define group identities and worldviews, which Rawls calls 'comprehensive' rather than minimal forms of collective agreement (Rawls 1985). It might be thought that scientific statements might provide good grounds for such justification, providing evidence that then leads linearly to action or policy which the majority will accept as legitimate. However, one of the concerns of the alleged emergence of a post-truth culture is the way in which it is characterised by statements that make implicit or explicit appeals to emotion rather than to other criteria that allow them to be checked effectively, and how the sharing of such statements via social media neutralise the effects of claim-checking through public debate, thus undermining the role of public reason itself (Waisbord 2018).

Post-truth may be seen as concerning precisely because of this effect. However, the production of scientific knowledge, of public facts, has always been closely connected to wider political struggles, as, for example, in the growth of environmental regulation during the 1970s in the USA, which was itself the product of political conflict involving citizens and corporations over the right not to be subjected to environmental harm (Jasanoff and Simmet 2017, 757–59). Scholars working in the sociology of science have, since the 1960s, shown in various ways that the labour of actually doing science is inseparable from wider social contexts in ways that materially shape the content of what is done.

This has led to arguments to the effect that the sociology of scientific knowledge (SSK) in the 1960s and 1970s and later science and technology studies (STS) have contributed to the emergence of a post-truth culture (Fuller 2016), arguments which reflect earlier ones made regarding the alleged influence of academia on a culture of relativism, including relativism regarding scientific truth-claims (Bloom 1987; Sokal and Bricmont 1999). But the core of the research programmes of these subdisciplines was not relativism, but rather a scepticism towards the idea of an idealised scientific method and culture which existed independently of wider social practices and other institutions. The 'principle of symmetry' in SSK and STS does not propose that there is no reason to treat truth claims from scientists as having no higher epistemological status than those made by non-scientists. Instead, it expresses a methodological agnosticism about such status, offering instead explanations of how it comes to be accepted that certain scientific truths have been successful publicly demonstrated and others have not (Lynch 2017). From within these traditions, ideas of observational verification such as defended by the CEI are shown to be naïve. Ethnographies of scientific practice demonstrate how much labour is expended in creating data by constructing apparatus and experimental situations together. Contrary to the ideal of 'sound science' as dependent on purely given observational data, these studies demonstrate that, without the labour of construction and the practices and concepts that underlie it there is, in fact, no data to be had (Knorr-Cetina 1981) – in 'traditional' lab-based science as much as in modelling-dependent investigations such as those of climate science (Edwards 2010). Evidential uncertainties deriving from how data have to be *made* within all scientific activity are therefore inevitable.

SSK and STS have emphasised how part of this social labour of science includes prioritisation of certain kinds of investigation and not others. This essentially political question opens up further discussion of the public accountability of publicly funded science and technology (Ziman 2000), creating what we might call 'process uncertainty'. Questions regarding the ways in which scientific research demonstrates in public the credibility of its truth claims broaden into questions about how scientific workers can demonstrate publicly the credibility of claims about the public value of their research. Researchers have shown how critical questions about the priorities reflected in scientists' choices about what to research thus become part of the public reception of scientific work (Nelkin 1975; Wynne 2006b). Credibility and trust thus touch on much wider concerns than just whether researchers have 'got the science right'. Certainly, such concerns can be harnessed as part of clashes between already-constituted political interests. In the USA, the social use of science in the 1970s in the service of public regulation of environmentally-harmful private activities was undertaken in the interests of public trust. Subsequent reaction under the Reagan administration to this growth of regulatory culture sought to undermine this trust by depicting this use of science as epistemically speculative and 'biased' towards particular political interests (Jasanoff and Simmet 2017). This kind of criticism of the questions science is asking represents a strategic use of uncertainty like to those employed by private interests identified as 'merchants of doubt' (Oreskes 2015). On the other hand, directing sceptical reflection towards the prioritisations inherent in scientific research need not be vexatious in this way. Echoing the more explicitly epistemic criticisms advanced by scientists who view the IPCC's reporting as too conservative, Wynne (2010) points out that certain directions taken by climate research reflect policy agendas that incline towards gradualist assumptions about social change, and thus downplay the potential disruptive contribution of positive feedback loops to ACC.

CREDIBILITY, BELIEF AND MOTIVATED REASONING

SSK and STS show that the contribution of scientific evidence to public reason is not straightforwardly to provide information which then provides convincing reasons for changing beliefs about what the priorities for social cooperation should be, and then also for acting on these beliefs. Public reason demands credibility, but credibility is wider in scope than the epistemic guarantees scientists produce for their own work. In relation to wicked problems like ACC, uncertainties about the provenance, significance and scope of such evidence appear even more acute.

Assessing information for credibility is a way of trying to domesticate this uncertainty. But the psychological burden of doing so in contexts where the language in which this information is couched is highly unfamiliar and/or technical means that recipients tend to use unconscious heuristics as shortcuts. Once, it was assumed that scientific illiteracy (a deficit in knowledge) was the source of disbelief in scientific evidence (Sturgis and Allum 2004). However, a significant body of psychological research has shown that people tend to either ignore or at least selectively interpret scientific evidence, where it conflicts with their own ethical, political or religious world views (all these being examples of Rawls' comprehensive theories). This means that the kinds of evidence which, according at least to Rawls' definition of public reason, should assist in forming minimal political consensus around cooperative schemes, typically fails to do so. Explanations for this phenomenon have leveraged the concept of 'directional motivated reasoning' (or simply motivated reasoning) to account for it (Kunda 1990). This is reasoning that is not directed towards establishing whether a belief is true, but instead aims at preserving a value or belief from being undermined.

Such motivations might include preserving a valued identity (and its supporting beliefs) against threats from new information, or avoiding perceived excessive cognitive effort. Motivated reasoning aims at reaching defensible conclusions, but these may not necessarily be correct ones – and nor is their correctness necessarily of ultimate concern. It avoids strenuously testing new information for accuracy, and instead affirms or denies it depending on the degree of fit with what is already believed (Kahan 2013). Motivated reasoning therefore tends to be manifested in cognitive shortcuts or heuristics that have been associated by Daniel Kahneman (2011) with what he calls System 1 thinking, that is, reasoning which works by fitting new information into existing patterns, rather than disturbing existing structures with new information.

The role of different modes of motivated reasoning in relation to identity has been of great interest. Social science research suggests that reasoning away contradictions is psychologically easier than revising feelings (Redlawsk, Civettini, and Emmerson 2010). This protects people's construction, through narrative, of a stable self-concept, particularly where such narratives are anchored by firm convictions. People who hold strong opinions on complex social issues are likely to examine relevant empirical evidence in a biased manner. They are apt to accept "confirming" evidence at face value while subjecting "disconfirming" evidence to critical evaluation, and, as a result, draw undue support for their initial positions from mixed or random empirical findings. Even where advanced levels of cognitive reasoning skills are present, people tend to use these in ways which help to confirm their prior beliefs, particularly where these are connected to strong commitments central to identities (Kahan et al. 2013; Nyhan and Reifler 2010). This is particularly the case where these commitments are associated with established political opposition to those with contrasting identities (Van Boven, Ehret, and Sherman 2018).

The effects of motivated reasoning have been noted in relation to climate change. While much effort in public engagement on climate change has focused on how to get across to 'the public' that the overwhelming consensus among climate scientists is that climate change is mainly anthropogenic in origin (van der Linden et al. 2014), the effects of such effort have, it is argued, not been positive (Kahan and Carpenter 2017). Drawing on the motivated reasoning literature, it is therefore not so much a lack of information or deficit in scientific understanding that is to blame for excessive scepticism towards the reality of human induced climate change (Whitmarsh 2009). Rather, it could be said to be a sense of occupying a particular position in the world, with which one's beliefs have to align. In particular, one's sense of being part of a particular political community, distinguished from others who hold values felt to be at odds with one's own deeper commitments, has significant effects. Avoiding identity-related uncertainty about how the wider political community fits together and where one is within it provides a powerful motivation for not accepting information that may trouble this picture. The likelihood of Republicans with high levels of scientific knowledge being sceptical of statements about human responsibility for climate change as much higher than that of Democrats reaching such sceptical conclusions, for example. For such people, scientific statements supporting ideas about anthropogenic climate change appear to have implications which are politically uncomfortable.

FROM EVIDENCE TO ACTION

Psychological research on motivated reasoning shows that the deficit model of science communication fails in practice, but also highlights how truth and accuracy are two values among others that guide reasoning, but that other values also have an influence here – and particularly, that other values incline people more to act in particular ways. This is not necessarily to suggest that psychological research suggests that people are – because of motivations not reducible to a desire for accuracy – temperamentally relativist. Rather, it suggests that human beings, as creatures whose lives are characterised by a range of diverse commitments, tend to weigh against each other a variety of values in determining what to believe and how to act. Where contexts for decision making are characterised by significant uncertainty and difficulties with establishing credibility, the most emotionally significant among these values can provide important heuristic value for reducing uncertainty to manageable proportions.

This may be what people *in fact* do. But given the rigour with which (as SSK and STS point out) scientists produce their data and explanations, *should* people evaluate it differently? Should scientific evidence have a special normative weight, on the basis of which we should grant it a unique status in public reason? There are good reasons for denying this, which nonetheless do not lead to relativism. These have to do with the difference between reasons for forming beliefs or performing certain actions that derive from the standards which govern a practice or practices (e.g. scientific research) and reasons external to such a practice (O'Neill 1993). Haller (2002) offers the following example. If I asked 'do you think these two dice will come up sevens next throw?', then supposing we have the relevant knowledge about how to calculate the chance of independent events, and data about factors affecting the outcome (fair dice, etc.) we have tools for forming a belief about the future which would have epistemic authority, based on a sizeable corpus of research on mathematical probability. What's more, this belief would also have normative authority for us, concerned as we are with accuracy in probability calculation above all else. That is, it would incline us to match our beliefs to the evidence.

However, this is a different consideration to whether we should do anything else as a result of holding a belief about the probable outcome of the dice throw. For example, should knowledge of the odds incline us to think it worth gambling £100 (that is, committing ourselves to a specific action that may lead to a loss) on seven being thrown is a different question. We might have an epistemically-justifiable belief about the outcome, but this is not the same as having a morally or even pragmatically justifiable belief about what to do. Suppose that we need the £100 to buy food for our family for the next week. That then gives us a reason to act in a specific way which the belief about the outcome does not, by itself, provide. The normative authority carried by the outcome of our correctly arrived-at probabilistic reasoning does not translate into additional normative authority for acting in a particular way.

Values other than truth (or reliability, or accuracy) have a large bearing on our decision. The authority of scientific propositions is internal to the practices of science, and thus can provide normative guidance for what scientists do (including the ways in which they form and change their beliefs). In public life, a variety of values and motivations (such as identity, as suggested by psychological research on motivated reasoning) are internal to the practices of political reasoning. The normative authority of scientific propositions, however, is external to these practices, in the same way that a critic of evolution's reference to an interpretation of a passage in the Bible or Koran has normative authority that is entirely external to a scientist's defence of evolution (O'Neill 1993).

Normative authority and credibility may not be entirely identical, but even if we bracket out the other sources of uncertainty about credibility that we have discussed, there is not necessarily anything special about scientific evidence, epistemically speaking, which should straightforwardly incline someone to take specific actions in the face of normative uncertainty. Instead, as has been suggested by STS researchers (Wynne 2006a) the normative authority proper to scientific evidence in the case of wicked problems can perhaps be sought in the role science has in delineating the nature and extent of uncertainties into the spotlight. Constructing projections of potential futures which allow us to identify what we do not and cannot know about the potential outcomes of processes like ACC can itself be a valuable input into determining what to do.

CONCLUSION: ASKING THE RIGHT QUESTIONS ABOUT CREDIBILITY

There is scope for pointing out that institutions and individuals tend to classify knowledge which could disrupt their view of the world as 'uncomfortable' (Rayner 2012). This has been seen as true of both institutions like the IPCC, as Wynne points out, and individuals committed to specific political identities. But central to this discomfort are the uncertainties which provide the context within which the credibility of scientific information as the basis for political judgement has to be established. Post-truth, as a concept, assumes that there was a time when the link between scientific evidence and policy or action was direct and clear. But as scholarship in the sociology of science and technology has shown, the links between scientific findings and policy have never been linear in this sense. Credibility for scientific evidence is not established through scientific work alone. Further, research on motivated reasoning shows that to deal with uncertainties surrounding the credibility of evidence as a guide to action, people often rely on heuristics for reasoning that bring values other than accuracy into play. Finally, philosophical reflections on the adequacy of scientific evidence as a motivation for changing non-scientific beliefs and acting in particular ways suggest that more is needed. The kind of consensus on the goals of social cooperation that Rawls' concept of

public reason demands requires credible grounds for reaching consensus. But when it comes to wicked problems like ACC, establishing credibility and normative authority is difficult.

Where does this leave us? The kind of consensus on cooperation in response to ACC that public reason in Rawls' sense is seeking can certainly be informed by scientific evidence, but cannot in the last instance be determined by it. Whatever counts as reliable scientific consensus is not the only guiding value relevant to political deliberation. If we demystify the relationship between post-truth and ACC debates, then perhaps the terrain of debate can shift. Consensus on appropriate social cooperation in the face of novel, wicked problems has two potential pathways. On the one hand, there is the possibility of foregrounding the extent and nature of uncertainty as being itself a major input into decision making. As repeated experiences with public deliberation on novel technologies have demonstrated, lay participants often raise this an a key moral and political consideration (e.g. Gavelin, Wilson, and Doubleday 2007) On the other, there is the possibility of reframing decision-making around ACC so that a range of values and priorities are foregrounded as terrain for potential consensus, rather than concentrating on achieving agreement on key aspects of climate science (Pearce et al. 2017). In practice, these strategies need to be connected (Corner and Groves 2014), as they are in general within precautionary approaches to decision making, where it is accepted that 'policies demand to be undertaken without firm foundation in fact' (Jasanoff and Simmet 2017, 759).

In precautionary approaches, decisions depend on the identification of *plausible* unacceptable losses, which pose problems structurally similar to Pascal's Wager, as Haller (2002) points out. On the one hand, we may be presented with more or less certain small gains (via business as usual, for example) that are nevertheless linked to the prospect of enormous and irremediable loss (via business as usual and its projected influence on climate change). On the other, we have action taken to head off this prospect of loss (e.g. radical cuts in greenhouse gas emission). In such cases, we do not need to wait for models to be validated by observational evidence, in the hope that arriving at agreed-upon truth will motivate change. Indeed, dwelling on the fine print of the scientific evidence (notwithstanding whether one happens to be a representative of current climate science consensus or one of its dissenters) is, as Demeritt (2006) puts it, bad politics. On the terrain occupied by public reason, uncertainty is not itself a reason for inaction. Indeed, often the opposite is the case. To make uncertainty a reason for action, it is necessary to be alert to the potential impact of unacceptable loss on a range of public values (well-being, biospherical health, economic activity and so on). Framing the problem in this way can also benefit from an additional framing that looks for a minimum basis for consensus on cooperation around desired end-points other than (but related to) greenhouse gas reduction, such as that of lessening dependence on fossil fuels. Reframing in this way may command support from those who are suspicious of climate change discourse on political grounds (Pidgeon et al. 2014).

REFERENCES

Baker, Erik. 2017. "Truth under Trump: Climate Change, Space Exploration, and 'Politicized Science.'" *First 100 Days: Narratives of Normalization and Disruption* (blog). February 30, 2017. http://first100days.stsprogram.org/2017/01/30/truth-under-trump-climate-change-space-exploration-and-politicized-science/.

Bloom, Allan. 1987. *Closing of the American Mind*. New York: Simon and Schuster.

Corner, Adam, and Christopher Groves. 2014. “Breaking the Climate Change Communication Deadlock.” *Nature Climate Change*, no. 4 (August): 743–45. https://doi.org/10.1038/nclimate2348.

Demeritt, David. 2006. “Science Studies, Climate Change and the Prospects for Constructivist Critique.” *Economy and Society* 35 (3): 453–79. https://doi.org/10.1080/03085140600845024.

Diethelm, Pascal, and Martin McKee. 2009. “Denialism: What Is It and How Should Scientists Respond?” *European Journal of Public Health* 19 (1): 2–4. https://doi.org/10.1093/eurpub/ckn139.

Editorial. 2018. “The Challenge of the Post-Truth Era.” *Nature Cell Biology* 20 (11): 1231. https://doi.org/10.1038/s41556-018-0231-z.

Edwards, Paul N. 2010. *A Vast Machine: Computer Models, Climate Data, and the Politics of Global Warming*. Cambridge, MA: MIT Press.

Fuller, Steve. 2016. “Embrace the Inner Fox: Post-Truth as the STS Symmetry Principle Universalized, Steve Fuller.” *Social Epistemology Review and Reply Collective* (blog). December 25, 2016. https://social-epistemology.com/2016/12/25/embrace-the-inner-fox-post-truth-as-the-sts-symmetry-principle-universalized-steve-fuller/.

Gavelin, Karin, Richard Wilson, and Robert Doubleday. 2007. “Democratic Technologies? The Final Report of the Nanotechnology Engagement Group (NEG).” Involve.

Haller, S. F. 2002. *Apocalypse Soon?: Wagering on Warnings of Global Catastrophe*. Montreal: MQUP. http://books.google.co.uk/books?id=Qt_J4YhzPncC.

Horner, Christopher C. 2002. “CEI’s Petition to EPA to Cease Dissemination of Climate Action Report.” Regulatory Comments and Testimony. *Competitive Enterprise Institute* (blog). April 6, 2002. https://cei.org/outreach-regulatory-comments-and-testimony/ceis-petition-epa-cease-dissemination-climate-action-repo.

Jasanoff, Sheila, and Hilton R Simmet. 2017. “No Funeral Bells: Public Reason in a ‘Post-Truth’ Age.” *Social Studies of Science* 47 (5): 751–70. https://doi.org/10.1177/0306312717731936.

Kahan, Dan M. 2013. “Ideology, Motivated Reasoning, and Cognitive Reflection: An Experimental Study.” *Judgment and Decision Making*, no. 8: 407–24.

Kahan, Dan M., and Katherine Carpenter. 2017. “Reply to ‘Culture versus Cognition Is a False Dilemma.’” *Nature Climate Change* 7 (7): 457–58. https://doi.org/10.1038/nclimate3324.

Kahan, Dan M., Ellen Peters, Erica Dawson, and Paul Slovic. 2013. “Motivated Numeracy and Enlightened Self-Government.” *Behavioural Public Policy*, no. 1: 54–86.

Kahneman, Daniel. 2011. *Thinking, Fast and Slow*. London: Farrar, Straus and Giroux.

Keeling, R. 2018. “Resplandy et Al. Correction and Response.” *Real Climate* (blog). November 14, 2018. http://www.realclimate.org/index.php/archives/2018/11/resplandy-et-al-correction-and-response/.

Kennedy, David. 2017. “It’s Not about Facts. It’s about Politics.” *First 100 Days: Narratives of Normalization and Disruption* (blog). November 5, 2017. http://first100days.stsprogram.org/.

Knorr-Cetina, Karin. 1981. *The Manufacture of Knowledge: An Essay on the Constructivist and Contextual Nature of Science*. Pergamon Press.

Kunda, Ziva. 1990. “The Case for Motivated Reasoning.” *Psychological Bulletin* 108 (3): 480.

Smith, N., & Leiserowitz, A. (2012). The Rise of Global Warming Skepticism: Exploring Affective Image Associations in the United States Over Time. *Risk Analysis*, 32(6), 1021–1032. https://doi.org/10.1111/j.1539-6924.2012.01801.x

Linden, Sander L. van der, Anthony A. Leiserowitz, Geoffrey D. Feinberg, and Edward W. Maibach. 2014. “How to Communicate the Scientific Consensus on Climate Change: Plain Facts, Pie Charts or Metaphors?” *Climatic Change* 126 (1): 255–62. https://doi.org/10.1007/s10584-014-1190-4.

Lynch, Michael. 2017. “STS, Symmetry and Post-Truth.” *Social Studies of Science* 47 (4): 593–99. https://doi.org/10.1177/0306312717720308.

Medhaug, Iselin, Martin B. Stolpe, Erich M. Fischer, and Reto Knutti. 2017. “Reconciling Controversies about the ‘Global Warming Hiatus.’” *Nature* 545 (7652): 41-+. https://doi.org/10.1038/nature22315.

Michaels, David. 2008. “Manufactured Uncertainty.” In *Agnotology: The Making and Unmaking of Ignorance*, 90–107. Stanford, CA: Stanford University Press.

Nelkin, Dorothy. 1975. “The Political Impact of Technical Expertise.” *Social Studies of Science* 5: 35–54.

Nyhan, Brendan, and Jason Reifler. 2010. “When Corrections Fail: The Persistence of Political Misperceptions.” *Political Behavior* 32 (2): 303–30. https://doi.org/10.1007/s11109-010-9112-2.

O’Neill, John. 1993. *Ecology, Policy and Politics*. London: Routledge.

Oreskes, Naomi. 2015. “The Fact of Uncertainty, the Uncertainty of Facts and the Cultural Resonance of Doubt.” *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences* 373 (2055): 20140455. https://doi.org/10.1098/rsta.2014.0455.

Pearce, Warren, Reiner Grundmann, Mike Hulme, Sujatha Raman, Eleanor Hadley Kershaw, and Judith Tsouvalis. 2017. “A Reply to Cook and Oreskes on Climate Science Consensus Messaging.” *Environmental Communication* 11 (6): 736–39. https://doi.org/10.1080/17524032.2017.1392109.

Pidgeon, Nick, Christina Demski, Catherine Butler, Karen Parkhill, and Alexa Spence. 2014. “Creating a National Citizen Engagement Process for Energy Policy.” *Proceedings of the National Academy of Sciences of the United States of America* 111 (September): 13606–13. https://doi.org/10.1073/pnas.1317512111.

Rahmstorf, S. (2005). *The climate sceptics, weather catastrophes and climate change: Is there still hope for us?* Munich: Munich Re Group.

Rawls, John. 1985. “Justice as Fairness: Political Not Metaphysical.” *Philosophy & Public Affairs* 14 (3): 223–51. https://doi.org/10.2307/2265349.

Rayner, Steve. 2012. “Uncomfortable Knowledge: The Social Construction of Ignorance in Science and Environmental Policy Discourses.” *Economy and Society* 41 (1): 107–25. https://doi.org/10.1080/03085147.2011.637335.

Redlawsk, David P., Andrew J. W. Civettini, and Karen M. Emmerson. 2010. “The Affective Tipping Point: Do Motivated Reasoners Ever ‘Get It’?” *Political Psychology* 31 (4): 563–93. https://doi.org/10.1111/j.1467-9221.2010.00772.x.

Sokal, Alan, and Jean Bricmont. 1999. *Fashionable Nonsense: Postmodern Intellectuals’ Abuse of Science*. New York: St Martins Press.

Sturgis, Patrick, and Nick Allum. 2004. “Science in Society: Re-Evaluating the Deficit Model of Public Attitudes.” *Public Understanding of Science* 13 (1): 55–74. https://doi.org/10.1177/0963662504042690.

Van Boven, Leaf, Phillip J. Ehret, and David K. Sherman. 2018. “Psychological Barriers to Bipartisan Public Support for Climate Policy.” *Perspectives on Psychological Science* 13 (4): 492–507. https://doi.org/10.1177/1745691617748966.

Waisbord, Silvio. 2018. “Why Populism Is Troubling for Democratic Communication.” *Communication, Culture and Critique* 11 (1): 21–34. https://doi.org/10.1093/ccc/tcx005.

Whitmarsh, Lorraine. 2009. “What’s in a Name? Commonalities and Differences in Public Understanding of ‘Climate Change’ and ‘Global Warming.’” *Public Understanding of Science* 18 (4): 401–20. https://doi.org/10.1177/0963662506073088.

———. (2011). Scepticism and uncertainty about climate change: Dimensions, determinants and change over time. Global Environmental Change, 21(2), 690–700. https://doi.org/10.1016/j.gloenvcha.2011.01.016

Wynne, Brian. 2006a. “Afterword.” In *Governing at the Nanoscale,Äîpeople, Policies and Emerging Technologies*, edited by M. Kearnes, P. Macnaghten, and J. Wilsdon. London: Demos.

———. 2006b. “Public Engagement as Means of Restoring Trust in Science? Hitting the Notes, but Missing the Music.” *Community Genetics* 9 (3): 211–20.

———. 2010. “Strange Weather, Again.” *Theory, Culture & Society* 27: 289–305. https://doi.org/10.1177/0263276410361499.

Ziman, John M. 2000. *Real Science: What It Is, and What It Means*. Cambridge: Cambridge University Press.

Further Reading

For further discussion of many of the issues which feature in this review, see the open access online journal and blog, *Social Epistemology Review and Reply Collective*, https://social-epistemology.com/