Language, Power and Public Engagement in Science

Melanie Smallman, Department of Science and Technology Studies, University College London. (2019)

In the UK and many European Countries, in the early 21st Century the role of science communicators has been characterised as shifting from one of explaining science to the public to one of 'engaging' the public in discussions and debate (M. L. Smallman, Lock, and Miller 2020). For many practitioners, this has meant a change in approach: I have heard many colleagues referring to 'dialogue' as a new communication model, requiring a focus on two-way rather than one-way discourse and greater audience participation instead of information sharing. In this chapter, I will review the literature that argues that thinking about this shift as a change in communication model alone misses the crucial issue at stake in the relationship between science and society and that moving to dialogue and public engagement is about a shift in power not just in communication. Building on that, I will go on to argue that when it comes to mediating the relationship between science and society, power and communication are different faces of the same coin and that understanding the language we use can help us understand how power is enacted, attributed and managed within public engagement exercises.

During the late 20th Century, a number of science-based public controversies emerged across Europe and the US – from nuclear power and acid rain to 'Mad Cow Disease' and genetically modified foods. Initially the scientific community interpreted this as a 'problem' with the relationship between science and society, stemming from the public's lack of understanding of science – people were mistrustful of science because they didn't understand it; education and information was the answer. A movement to improve the public's understanding of science emerged, and scientists were encouraged to describe their work in ways that make sense to non-experts. For instance, The Royal Society's well-known report on 'The Public Understanding of Science' (1985) drew the conclusion that "Scientists must learn to communicate with the public, be willing to do so, and indeed consider it their duty to do so. All scientists need, therefore, to learn about the media and their constraints and learn how to explain science simply, without jargon and without being condescending." (The Royal Society, 1985). Language was clearly seen as a tool for helping bring the public around to the scientific way of thinking.

Very quickly however it became apparent that the relationship between knowledge and attitudes was more complicated. Rather than more knowledge or information reassuring the public, researchers were finding that in many instances more information was making public opposition more entrenched, particularly when talking about controversial topics like nuclear power or embryology research (Evans and Durant 1995). People's attitudes to science and technology were case specific, shaped by their own values and world views and usually had more to do with the social and ethical implications of science, rather than how science worked, or the language with which it was explained (Evans & Durant, 1995b; Frewer, Howard, & Shepherd, 1998; Slovic & Peters, 1998). Instead, the argument developed that remedying this apparently broken relationship between science and society needed dialogue between experts and lay people. This was most clearly (and significantly) established in the 2000 House of

Lords report ‘Science and Society’ (House of Lords Science and Technology Select Committee, 2000) which called for a ‘new mood for dialogue’ in order to restore public confidence in government’s use of science. In particular, this report triggered the launch of the UK Government’s ScienceWise programme, which went on to organise numerous public dialogue events around the UK, on topics ranging from data privacy to renewable energy (Warburton 2011) and which was followed by a new focus amongst science communicators on ‘public engagement’ rather than explaining science (M. Smallman, Lock, and Miller 2020).

This, in my view, is where the argument became confused. The academic literature was seeing this new mood for dialogue as a way to shift power from scientists to the public. To address public distrust in the kind of world science was producing, dialogue allowed the public to be involved in deciding the direction science should take (for instance Durant, 1999; Grove-White, 1997; Irwin & Wynne, 1996; Irwin, 2001; Wynne, 1998). In practice however, this same mood for dialogue was seen as a new way of communicating with the public and bringing the public round to the scientists’ way of seeing things, rather than democratising science and technology. Indeed, one of the early responses of UK’s science communication community was to debate terminology – whether the movement should still be called science communication or the public understanding of science or whether they should adopt a term that more closely reflected this dialogical approach. I argue that the community finally settled upon the term “public engagement” (as opposed to ‘public dialogue’ or ‘public participation’ which was more typically found in the academic literature) because it was sufficiently non-specific to be able to accommodate all forms of communication and overlook any transfer of power from the scientific community to the public.

The difference in the purpose of public dialogue in theory and practice has also been widely flagged in evaluations of public dialogue events – not just in the UK. For instance, the UK Government’s 2003 GM Nation debate was described by evaluators as primarily a legitimation exercise (A. Irwin, Jensen, and Jones 2012a); a broader review of European public engagement practices on a range of scientific topics similarly concluded that recent changes in science communication had not been as profound as had been hoped, with public engagement activities at best being limited to gauging public opinion rather than enacting more democratic aspirations (Kurath and Gisler 2009). These problems were summed up by researcher Brian Wynne in his paper evaluating the move to dialogue, which he titled “Hitting the notes but missing the music” (B. Wynne 2006).

As I have argued previously, (M. Smallman 2014; M. Smallman 2017) evaluations of these participatory exercises have however tended to focus on the *process* of dialogue – whether particular groups have had a say, whether the discussions were framed by the participants or organisers, for instance. The content and form of the discussions themselves have been largely unexplored, even though the nature of the discussions taking place in these events – what is discussed and how – seems to be an important matter to investigate if we are interested in understanding more about how power is enacted, conserved or shared. Furthermore, research in this area has tended to focus on particular examples or case studies, at the expense of larger over-arching lessons and an understanding the ‘higher order game’ of which public dialogue is a part - discussions of the shape of the world that science is creating and created by (A. Irwin, Jensen, and Jones 2012b; Stilgoe, Lock, and Wilsdon 2014).

My research over the past few years has set out to address these gaps in our understanding – to learn more about what is said in public dialogue events, how these discussions differ from more expert discussions and to draw broader lessons about power balances. To do this, I have been looking at public and expert discussions across topics and over a long timeline of ten years. More specifically, I have been looking at the words that different groups of people use to talk about science and technology, to understand the underlying discourses, perspectives and relationships. Given the ambition of the scale of this project – and the volume of data analysis that ten years' of discussions generates - I turned to a computational approach to text analysis (often called text mining methods or computer assisted text analysis). The technique I use is based upon the Word Space Model (Chartier and Meunier 2011), which is a computational model that builds on Saussure's work in structural linguistics (Saussure 1916) and describes how meaning for words is derived by looking at the way in which words are distributed and situated across a large textual data source (Sahlgren 2006). It is based on two assumptions:

1. The meaning of a word is built through its use
2. Words that have similar co-occurrence patterns have similar meanings.

On this basis, if different stakeholders or speakers have different meanings and purposes attached to particular words, then these differences will be reflected in the way they use these words. By looking at the relationship between words in a text and how words occur or cluster together, which the computer helps me to do by creating a statistical model of text documents, it is possible to identify any common underlying narratives.

So, what have I learned about the power relationships lying within public dialogue events by looking at the language used by dialogue participants and scientific experts?

To begin, I have found the outputs of public dialogue events have little power or influence in decision making compared to the power of scientific expertise (M. Smallman 2017). I have previously argued that at least part of this lack of power comes from the absence of agency within public dialogue events that would compel policymakers to pay attention to their outputs – policymakers are not mandated to act on the outputs, and no one is given the role of advocating on behalf of the outputs (M. Smallman 2016). Alongside that, I have also described a number of linguistic features of public discourses that are likely to affect their credibility and impact on policy further (M. Smallman 2017; M. Smallman 2016):

Firstly, the language of the public dialogues tended to focus on people rather than technologies. Words such as 'person,' 'public,' 'woman' or 'adult' were common, as well as words which described the role of people, such as 'patients,' 'experts,' 'scientists' and 'policymakers' (M. Smallman 2017).

Secondly, at the heart of most of the public discussions was the idea of nature and naturalness. This was not just found in discussions around environmental technologies, but also in discussions about stem cells and hybrid embryos. Specifically, the public discussions tended to give agency to Nature, with nature's ability to wreak revenge evoked as a reason why we should not engage with certain activities that transgress what is natural (M. Smallman 2017).

Thirdly, while the public discourses were broadly supportive of science (there was no evidence of an outright rejection of any particular technology, for instance), they were nevertheless not as enthusiastically supportive of non-biomedical technologies as scientists were. Terms like ‘slippery slope’ were used in the public discussions, indicating that science is seen as moving in an inevitable direction and beyond our control. This sense of unease was coupled with a scepticism of the role of industry, which was seen as a diverting force. I have described this public ambivalence as ‘contingent optimism’ which contrasts with the expert outlook of ‘science to the rescue’ (M. Smallman 2017).

In contrast, scientists’ discussions tended to focus on the science itself, with words like ‘nanoparticles’, ‘mitochondria’, and ‘cell’ being common. When people were discussed, it is in relation to that science and technology – as ‘stakeholders’ in relation to public concerns, or as ‘donors’ in relation to stem cells, for example. For the experts, ‘natural’ is a technical term to refer to non-GM strains of plant or animal, but in many instances is a term used to refer to a less favourable situation. Social and ethical issues were discussed as ‘public’ concerns to be solved. Economic terms were commonly used to describe key benefits of science and, tying in with the economic arguments, time is also an important rhetorical concept – the sense that decisions need to be made now and giving an urgency to science (M. Smallman 2017).

I have described previously (M. Smallman 2017) how others have argued that the technical language used in scientific discussions is a way of displaying competence and credibility amongst policymakers (Hilgartner 2000). The use of scientific terms also appear to be useful for what Gieryn (1983) describes as boundary-work – drawing clear lines between what is scientists’ business and what is policy/public business, effectively shutting out the public from these technical discussions.

In contrast, the focus on people and the importance of nature displayed in the public discourses potentially reinforce policy perceptions of the public being “emotional, untutored in probabilistic thinking and incapable of rational intervention in technical debates” (Jasanoff and Kim 2009). Cook (2004), talking to GM scientists involved in public engagement activities, reported that the public were seen to be making emotional (rather than rational) assessments of technologies, and to therefore be being vulnerable to manipulation by the press, NGOs and politicians. It seems then that not only is the scientific focus and language of the expert discussions giving real and rhetorical power to the expert discourses, but in contrast, the public discourses run the risk of looking emotional rather than rational – and therefore vulnerable to manipulation by the press, NGOs and politicians (Cook 2004; M. Smallman 2017).

Furthermore, others have pointed out that when the public voice anything but full throated support of science and innovation, it is heard as opposition by policymakers and therefore dismissed because they could stifle scientific research or economic development (Dryzek et al. 2008) or viewed as unformed views to be brought around (Thorpe and Gregory 2010). While I have argued (M Smallman 2019) that this is an over-simplification of public perspectives, it seems reasonable to suppose that the outputs of public dialogue events could have less currency with policymakers if they were seen to hold back economic development, especially in comparison to scientific experts’ enthusiastic advocacy of the economic opportunities offered by science and innovation.

Rhetorical devices in Expert discourses

Beyond these matters of vocabulary however, I have identified a number of rhetorical devices throughout the expert discussions, which serve to reinforce the value and power of these expert discourses further (M. Smallman 2017; M Smallman 2019). These devices appear to have been adopted in order to bring the science to life for the policymakers, but they have the effect of providing powerful promises, reassurances and certainty that appeal directly to the policymakers' ideas of and aspirations for science:

a. **Hyperbolic framing**

   Extreme examples of the benefits to be accrued or problems to be solved by science were used by scientists to describe their work to policymakers: Curing cancer and Alzheimer's disease, tackling climate change, the looming energy crisis and the need to feed a growing world population were all important framing devices (for sometimes still abstract areas of scientific research):

> *"The greatest changes we will see in the 21st century may be brought to us through developments in our understanding of the brain. These advancements may offer revolutionary treatments for the brain and could see the end of neurodegenerative disorders such as Parkinson's and Alzheimer's."*
> ***Academy of Medical Science's report on Brain Science, 2008***

> *"In the field of energy, synthetic biology is being used to develop far more efficient biofuels. These developments have the potential to alleviate current problems with biofuels. For example, competition for land use between energy and food crops."*
> ***Royal Academy of Engineering, Synthetic Biology 2009***

The importance of science in solving these pressing concerns was further emphasised by the use of superlatives – science won't just play a part, but is fundamental or vital to solving these problems:

> *"Studies, particularly in mice, have played a fundamental role in research over the past 50 years to understand the complex processes underpinning cancer"*
> ***Animals containing human material, Academy of Medical Sciences, 2011***

> *"A transition towards renewable bio-based feedstocks is vital for the production of chemicals, materials, fuels and energy, to lessen dependence of fossil fuels and achieve climate goals."*
> ***Industrial biotechnology, Industrial Biotechnology Innovation and Growth Team, 2005.***

As I will discuss further below (and in Smallman 2017; 2019), while these rhetorical approaches are effective in bringing science to life, they also appear to 'fix' ideas of what particular areas of science can achieve and consequently limit discussion of the futures possible with science. In the case of their use with policymakers, they also appear to be effective in gathering resources and power, offering unequivocal arguments about the role of science in tackling the biggest problems of the world.

b. Bundling and closing public concerns

I found that in the expert reports complex public concerns around safety, moral hazard, the role of industry (for instance) tended to be bundled into one category of 'social and ethical issues,' which could then be addressed as a single collective. While these matters are often created by and inherently part of the technologies being discussed, bundling them into this single category has the effect of making messy and intractable problems contained and manageable.

> *"The development of synthetic biology brings with it a key number of ethical and societal implications which must be identified and addressed."*
> ***Royal Academy of Engineering Synthetic Biology 2009.***

> *"The dialogue revealed that most people are supportive of research but with conditions on how and why it is conducted."*
> ***Synthetic Biology Road Map, UK Synthetic Biology Road Map Coordination group, 2012.***

> *"This independent report to government identifies a number of issues that if addressed will make a real difference and put in place the mechanisms to ensure that the UK truly seizes this global opportunity."*
> ***Animals Containing Human Material, Academy of Medical Sciences, 2011.***

> *"If geoengineering is to play a role in reducing climate change an active and international programme of public and civil society dialogue will be required to identify and address concerns about potential environmental social and economic impacts and unintended consequences."*
> ***Geoengineering, The Royal Society, 2009***

In this way, these issues are also closed down and treated as something that can be dealt with or solved. The scientists have public permission to act; they simply have to address these issues. Public concerns, which the public discuss as inherent properties of the technologies, are interpreted as 'conditions' on how the research should go ahead and epiphenomena that can be dealt with apart from the science.

In many instances, obstacles to progress (such as social and ethical concerns) are also presented as temporary. Objectors are not saying no, but just not yet:

> *"A further review following such studies in about a decade would be appropriate to reconsider the prospects for such approaches at that time, in the light of advances in relevant technologies and the likelihood of some more permanent geoengineering contribution possibly being needed"*
> ***Geoengineering, The Royal Society, 2009***

"There are others who reason that this approach understates the distinct differences between GM and non GM and that because the technology is relatively new, we know too little. The uncertainty is too great and there are too many gaps in knowledge to pursue it safely at the current time."
GM Science Review, GM Science Review Panel, 2003.

A tendency to discount uncertainty or to present it as manageable or knowable was also evident in the expert documents (M. Smallman 2017): The impression given is that we can know all of the risks associated with a new technology and that it is possible to address them:

"There are potential negative impacts on non-target organisms but in the case of insect resistance, field studies on commercially grown Bt crops have failed to identify any adverse reactions."
GM Science Review, GM Science Review Panel, 2003

c. Normalisation of problems

In the case of GM in particular, the problems associated with technologies were also normalised by building comparisons with the problems with 'acceptable' technologies. While the new technologies might have problems/issues associated with them, they are not important when you compare them to the problems we are dealing with already. That this technique seems to be particularly well used when talking about biotechnology, might reflect an awareness of the value put by the public on 'naturalness' – comparing new technologies to old ones highlights the 'unnaturalness' in techniques we already accept and therefore might seem to put GM on a level footing of acceptability:

"Mutation breeding for instance involves the production of unpredictable and undirected genetic changes and many thousands even millions of undesirable plants being discarded in order to identify plants with suitable qualities for further breeding,"
GM Science Review, GM Science Review Panel, 2003

"Might GM crops change agricultural practice in the UK? If so, what might be the likely consequences? It is widely acknowledged that modern non-GM agriculture has already had negative impacts on biodiversity and the wider environment in the UK."
GM Science Review, GM Science Review Panel, 2003

Hilgartner (2000) and Latour (Latour, 1987, Chapter 1) have pointed out that scientific texts use the rhetorical technique of anticipating reader's objections and trying to demolish them in advance. It is possible that this is shaping the experts' tendency to provide reassurance and close down debates around risk. Rather than representing an underlying belief that this science can do this, it reflects perhaps, a belief that policymakers want to be reassured and to be presented with certainties. Cook's work looking at scientists' attitudes to the GM debate (Cook 2004) found a similar tendency to perceive decisions around introduction of GM technology as entirely safety oriented and based on a rational choice model. He describes how the scientists' focus was almost exclusively on a cost benefit analysis of assessable safety issues relating the health and the environment, with no reference to unforeseen risk. The message is compelling – given the responses and opportunity to address these matters, it is possible that science can proceed in a manner that is satisfactory to everyone. There is nothing to worry about here.

Rhetorical devices in public dialogue

These rhetorical devices for describing science are not limited to scientific explanations for policymakers however. I have described elsewhere (Smallman 2019) how 'hyperbolic framing' was used within public dialogue activities – describing tentative, abstract science as 'cures for cancer' or 'solutions to climate change' when explaining science to the public. I have also argued that while these devices help to bring science to life in the context of 'upstream engagement,' they also 'fixed' ideas of what particular areas of science can achieve, leaving very little room for public participants to challenge or contest such ideas and futures and consequently limit discussion of the futures possible with science (M Smallman 2019).

In my view this is a significant concern for public dialogue advocates and suggests that differences between the public and scientific perspectives on science are likely to be underplayed in the dialogue events and subsequent reports – the rhetorical devices involved act to mask differences. This raises questions about what language we could use to bring upstream science to life without fixing dominant and expert imaginaries in the minds of the public participants. Indeed, what kind of language would be used if the public were asked to co-create scientific futures, based on the often mundane practices and impacts of science?

Conclusions

Drawing this chapter to a close, I have described how the key features of the public vocabulary – a focus on people rather than technologies, and on nature in particular – work to undermine the power of public perspectives compared to scientific perspectives, by making public views appear non-rational, emotional and easily influenced.

I have also described how rhetorical devices within the expert discussions have the effect of adding power to the scientific viewpoints by indicating that science is indispensable to policymakers, since it has a key role in tackling the issues of the day. I have also pointed out how the public discussions have been shaped by techniques such as 'hyperbolic framing,' which make it very difficult for participants to find a way to object to the science or technology being discussed. The discussions in public dialogues are very clearly framed and directed by the dominant scientific ideas, articulated by the experts participating in the debates, as well as the officials commissioning the discussion in the first place – and indeed act to reinforce and share these ideas.

Looking at the language within expert and public discussions of new and emerging science has therefore raised important questions about the purpose of dialogue, the power relationships within it and what scientists see as their roles. It also raises the question of whether and how public dialogue activities can be of value in broadening the perspectives from which scientific decisions draw, making science more socially robust or democratising science if the language of the discussions tips the power balance so far against the public being heard – or even having the chance to make up their own minds. Thorpe and Gregory

(2010) have argued that contrary to the motivations around democratisation of science that have been driving forces behind making public engagement a legitimate (and increasingly perceived as necessary) activity, public dialogue programmes potentially operate as forms of control and 'co-optation' that promote and shape the public as markets for new technological products. Looking at the discourses within the public dialogues, I have argued (here and in (M Smallman 2019) that they are playing a role in fixing the meanings of yet to be real technologies – not just for the public, but for the scientist and policymakers involved too. Furthermore, I have argued that the public have little choice but to support the scientific narrative of progress being presented to them. At best the dialogues are providing an opportunity for the public to outline the conditions for acceptance of technologies that are going to be developed. If upstream engagement is the important focus for public dialogue, then ways need to be found to create a space and a language in which the realities of science can be discussed – where the banality of the majority of applications of science are admitted and where we can move away from the 'cycle of promise' (Brown, Rip, and Lente 2003).

More importantly however, if the purpose of public engagement is to improve the relationship between science and society, it will be doomed to failure if (intentionally or otherwise) it becomes an exercise in 'fixing' the dominant scientific narrative in the minds of the public participants, or a power-battle of whose vision gets heard. As I have described earlier, decades of research means we know that any differences between expert and public views on science are usually not the result of a lack of knowledge on the part of the public, but because of genuine concerns about particular aspects of science, technology and the shape of the world we are building with them. Improving this relationship then calls for more open discussions and more speculative language about what science and technologies can and should be used for, so that together we can puzzle the troubles and solutions for the world ahead and share power so that out futures are genuinely negotiated together.

References

Brown, Nik, Arie Rip, and Harro Van Lente. 2003. "Expectations In & About Science and Technology a Background Paper for the ' Expectations ' Workshop of 13-14 June 2003."

Chartier, Jean Francois, and Jean-Guy Meunier. 2011. "Text Mining Methods for Social Representation Studies of Large Texts." *Papers on Social Representations* 20 (37.1-37.47). http://www.psych.lse.ac.uk/psr/PSR2011/20_38.pdf.

Dryzek, J. S., R. E. Goodin, A. Tucker, and B. Reber. 2008. "Promethean Elites Encounter Precautionary Publics: The Case of GM Foods." *Science, Technology & Human Values* 34 (3): 263–88. doi:10.1177/0162243907310297.

Durant, John. 1999. "Participatory Technology Assessment and the Democratic Model of the Public Understanding of Science." *Science and Public Policy* 26 (5): 313–19. doi:10.3152/147154399781782329.

Evans, Geoffrey, and John Durant. 1995. "The Relationship between Knowledge and Attitudes in the Public Understanding of Science in Britain." *Public Understanding of*

Science 4 (1): 57–74. doi:10.1088/0963-6625/4/1/004.
Frewer, Lynn J, Chaya Howard, and Richard Shepherd. 1998. “Understanding Public Attitudes to Technology.” *Journal of Risk Research* 1 (3). Taylor & Francis: 221–35. doi:10.1080/136698798377141.
Gieryn, Thomas. 1983. “Boundary Work and the Demarcation of Scienc Efrom Non-Science.” *Americal Sociological Review* 48 (6): 781–95. http://www.jstor.org/discover/10.2307/2095325?uid=3738032&uid=2&uid=4&sid=21101497420157.
Grove-White, Robin. 1997. “Environment, Risk and Democracy.” *Political Quarterly* 68 (B): 109–22. doi:10.1111/1467-923X.00120.
Hilgartner, Stephen. 2000. *Science on Stage: Expert Advice as Public Drama*. Vol. 8. Stanford University Press. https://books.google.co.uk/books/about/Science_on_Stage.html?id=vU8LauawsfkC&pgis=1.
House of Lords Science and Technology Select. 2000. “Science in Society.” http://www.publications.parliament.uk/pa/ld199900/ldselect/ldsctech/38/3801.htm.
Irwin, A., T. E. Jensen, and K. E. Jones. 2012a. “The Good, the Bad and the Perfect: Criticizing Engagement Practice.” *Social Studies of Science* 43 (1): 118–35. doi:10.1177/0306312712462461.
———. 2012b. “The Good, the Bad and the Perfect: Criticizing Engagement Practice.” *Social Studies of Science* 43 (1): 118–35. doi:10.1177/0306312712462461.
Irwin, Alan. 2001. “Constructing the Scientific Citizen: Science and Democracy in the Biosciences.” *Public Understanding of Science* 10 (1): 1–18. doi:10.1088/0963-6625/10/1/301.
Irwin, Alan, and Brian Wynne. 1996. *Misunderstanding Science?* Edited by A Irwin and B Wynne. Cambridge: Cambridge University Press. http://www.cambridge.org/gb/academic/subjects/history/history-science-and-technology/misunderstanding-science-public-reconstruction-science-and-technology.
Jasanoff, Sheila, and Sang-Hyun Kim. 2009. “Containing the Atom: Sociotechnical Imaginaries and Nuclear Power in the United States and South Korea.” *Minerva* 47 (2): 119–46. doi:10.1007/s11024-009-9124-4.
Kurath, Monika, and P. Gisler. 2009. “Informing, Involving or Engaging? Science Communication, in the Ages of Atom-, Bio- and Nanotechnology.” *Public Understanding of Science* 18 (5): 559–73. doi:10.1177/0963662509104723.
Latour, Bruno. 1987. *Science in Action: How to Follow Scientists and Engineers Through Society*. Harvard University Press. https://books.google.com/books?id=sC4bk4DZXTQC&pgis=1.
Sahlgren, Magnus. 2006. “The Word Space Model - Using Distributional Analysis to Represent Syntagmatic and Paradigmatic Relations between Words in High-Dimensional Vector Spaces.” http://www.sics.se/~mange/TheWordSpaceModel.pdf.
Saussure, Ferdinand de. 1916. *Course in General Linguistics*. Edited by Perry Meisel and Saussy Haun. 2011th ed. Columbia University Press. https://books.google.com/books?id=ffzWX9LeeykC&pgis=1.
Slovic, Paul, and E Peters. 1998. “The Importance of Worldviews on Risk Perception.” *Journal of Risk Decision and Policy* 3 (2): 167–200.
Smallman, M. 2014. “Public Understanding of Science in Turbulent Times III: Deficit to Dialogue, Champions to Critics.” *Public Understanding of Science,* September, 0963662514549141-. doi:10.1177/0963662514549141.
———. 2017. “Science to the Rescue or Contingent Progress? Comparing Ten Years’ of Public, Expert and Policy Discourses on New and Emerging Science and Technology in

the UK." *Public Understanding of Science*.
Smallman, M. L., S. Lock, and S. Miller. 2020. "A History of Modern Science Communication in the UK." In *The Emergence of Modern Science Communication.*, edited by T. Gasgoine, B. Lewenstein, L. Masserati, B. Schiele, P. Broks, M. Riedlinger, and J. Leach. ANU (Australian National University) Press.
Smallman, M. 2019. "Nothing to Do with the Science." *Social Studies of Science* In press.
Smallman, Melanie. 2017. "Science to the Rescue or Contingent Progress? Comparing 10 Years of Public, Expert and Policy Discourses on New and Emerging Science and Technology in the United Kingdom." *Public Understanding of Science*, May. SAGE PublicationsSage UK: London, England, 096366251770645. doi:10.1177/0963662517706452.
Smallman, Melanie Lynne. 2016. "What Has Been the Impact of Public Dialogue in Science and Technology on UK Policymaking?" UCL. http://discovery.ucl.ac.uk/1473234/.
Stilgoe, J., S. J. Lock, and J. Wilsdon. 2014. "Why Should We Promote Public Engagement with Science?" *Public Understanding of Science* 23 (1): 4–15. doi:10.1177/0963662513518154.
The Royal Society. 1985. "The Public Understanding of Science."
Thorpe, Charles, and Jane Gregory. 2010. "Producing the Post-Fordist Public: The Political Economy of Public Engagement with Science." *Science as Culture* 19 (3). Routledge: 273–301. doi:10.1080/09505430903194504.
Warburton, Dianne. 2011. "Evaluation of Sciencewise." http://www.sciencewise-erc.org.uk/cms/assets/Uploads/Publications/Sciencewise-Evaluation-Report-FINAL.pdf.
Wynne, B. 1998. "May the Sheep Safely Graze? A Reflexive View of the Expert–Lay Knowledge Divide : SAGE Knowledge." *Risk, Environment and Modernity: Towards a New Ecology*. http://knowledge.sagepub.com/view/risk-environment-and-modernity/n3.xml.
Wynne, Brian. 2006. "Public Engagement as a Means of Restoring Public Trust in Science--Hitting the Notes, but Missing the Music?" *Community Genetics* 9 (3): 211–20. doi:10.1159/000092659.