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Constructing Communication

Talking to Scientists About Talking to the Public

Sarah R. Davies
Durham University, UK

Recent work has started to explore "scientific understandings of publics" alongside public understandings of science. This study builds on this work to examine the ways in which public communication is talked about by scientists and engineers. The author identifies a range of ways of talking about the purposes and content of science communication to the public, arguing that the dominant framework for these is one-way communication, and that, in addition, such communication tends to be constructed as difficult and dangerous. However, the author further identifies a range of minority discourses that understand public communication in more complex terms.

Keywords: *science communication; scientific cultures; deficit model; dialogue; public communication*

Over the last two decades there has been an unprecedented level of encouragement for those working within the sciences to open up their disciplines and communicate with publics (Miller, 2001). The 1985 Bodmer Report (Royal Society, 1985) initiated a wave of funding for and interest in public communication, and—although language and practice may have changed—this impetus toward public engagement with science continues today (Bauer, Allum, & Miller, 2007). Scientists and engineers can apply for special grants to carry out public engagement work, from charitable bodies or learned societies such as the Wellcome Trust or the British Association for the Advancement of Science. Research Councils UK (RCUK), the major UK public funder of research, has a dedicated Science in Society unit that aims to "promote a free flow of information and exchange of views between researchers and members of the public" (RCUK, 2006).

It appears, then, that the Bodmer Report was successful in at least one of its aims: it argued that "scientists must learn to communicate with the public, be willing to do so, and indeed consider it their duty to do so" (Royal Society, 1985, p. 6). As Steve Miller argued after the 2000 House of

Lords Report on Science and Society (Miller, 2001), the scientific community has been very effectively mobilized as a result of this emphasis on public communication. Reports such as Davis (2004), Pearson, Pringle, and Thomas (1997), and Wiseman (1996) indicate the breadth of activities experts are involved in (debating fora, exhibitions in shopping centers, science in the mass media). My own data—discussed in more detail below—similarly indicate that scientists and engineers are at the very least aware of a push toward public communication, and in many cases have taken part in one or more science communication activities. The range of these is wide; with those to whom I spoke it ranged from department open days to going into schools to more traditional mass media activities such as writing for newspapers or appearing on TV or radio.

It seems that scientists and engineers today have the funds, the opportunities, and often the desire for public engagement (MORI, 2000). This means that it is vitally important to explore how they conceptualize and negotiate ideas of "the public" and of public communication. As Lévy-Leblond (1992) argued more than 15 years ago, "scientific understandings of publics" are just as important an area of study as "public understandings of science" (PUS). The majority of public engagement activities funded by governments and charities are currently not large-scale events with input from social scientists or PUS theorists. They are instead ad hoc and informal activities, such as open days or outreach programs to schools (as Turney, 2006, p. 87, noted, most are "small scale and local"). In practice, it is individuals or small groups of technical experts who come into contact with publics, not science as an institution or an establishment. And it is therefore the practices of individuals which will frame and shape the communication process.

The importance of this should not be underestimated. Work that has examined both dialogue processes (Irwin, 2001; Wynne, 2002) and more traditional science communication (Irwin & Wynne, 1996; Layton, Jenkins, Macgill, & Davey, 1993) has shown that framing is everything. Organizers or key participants have the power to shape the assumptions of the communication process, so that publics and processes can be positioned in particular ways and value systems—such as the primacy of scientific knowledge—can be imposed (Wynne, 2001). In the case of many points of contact between science and its publics, then, individual scientists' assumptions about the process they are involved in and the individuals they are interacting with will have an important impact on those processes.

Expert thinking on "the public," for many years an understudied area, has recently been receiving more attention. Work by Mike Michael, Guy Cook,

and Kevin Burchell, among others, has started to flesh out the ways in which publics are constructed and used by scientists (see Burchell, 2007; Cook, Pieri, & Robbins, 2004; Davies, 2008; Frewer et al., 2003; Michael & Birke, 1994; Michael & Brown, 2000; Young & Matthews, 2007), finding predominantly "deficit" models (Irwin & Wynne, 1996), but also some more flexible and positive constructions. However, little recent work has specifically examined scientists' ideas and assumptions about public communication and engagement, despite the fact that these will certainly affect the ways in which they engage in such activities.[1] This brief article seeks to go some way in redressing this balance by reporting an analysis of scientists and engineers' talk within group discussions about public communication.

In what follows, I briefly describe my methods, before moving on to draw some key themes on public communication out of my data. I examine the ways in which scientists talk about the content and purposes of science communication to the public, summing these up by arguing that a framework of *one-way communication* is consistently used. I further find that communication is consistently discussed in a way that suggests it is difficult or dangerous, before moving on to identify some competing and more complex notions of public communication. A key theme of this research is thus that there is a diverse range of ideas about public communication in scientific cultures: There is not one straightforward notion of what "public engagement" should involve, but rather diversity, flexibility, and disjunction.

Background to the Research

This analysis forms part of a broader study that examines "the public" and "science" in scientific talk (Davies, 2007). It seeks to identify the "social voices" of public communication within scientific communities, as Lemke (1995) understood the term. He wrote:

> We speak with the voices of our communities, and to the extent that we have individual voices, we fashion them out of the social voices already available to us, appropriating the words of others to speak a word of our own. (Lemke, 1995, pp. 24-25)

The study involved seven group discussions, each made up of between 3 and 10 participants. For both reasons of access and familiarity for participants, groups were composed of individuals from the same research or lab group and usually took place within a time slot allotted to a group or lab

meeting. In this way, an effort was made to create a naturalistic and comfortable environment for participants: The interview took place in a familiar place and with familiar people. The aim was that the kind of free discussion that would normally occur around a research paper or recent finding would be extended to the discussion topics the interviewer introduced. Research suggests that the cultures of scientific disciplines can be very different (Knorr-Cetina, 1999); it seems possible, then, that the social voices accessible within scientific cultures may also vary, and an effort was therefore made to speak to a range of these cultures. Groups were spread across a range of scientific and engineering disciplines, including life and physical sciences, environmental science, and engineering.[2] Discussion was focused through the use of a semistructured interview schedule by the researcher (Flick, 2002; Morgan, 1997); topics included participants' ideas for public communication on their research and the purposes of science communication. All talk was recorded and transcribed, and anonymized. As befits a study of talk-in-interaction, principles from discourse analysis were used for examining how particular meanings were constructed through the discussions (Silverman, 2001). In particular, discourse analytic approaches were used (see Cameron, 2001) to inform interpretative coding of the data (Flick, 2002) and to identify key themes and concepts; in this way, particular stories, discourses, or "social voices" of public communication were reconstructed (cf. Michael, 1991). In the following discussion, I show one or two quotes as examples; these are, of course, representative of a broader selection rather than comprehensive of the themes found.

Discourses of communication within these discussion transcripts are hugely messy, diverse, and complex (cf. Law, 2004). There is, quantitatively, *lots* of talk relating to communication—unsurprising given the discussion context and focus—but also qualitatively *lots of different kinds* of talk about communication. The group interview discussions were specifically framed in the context of public communication—scientific communication to laypeople—and therefore the majority of the talk is involved in discussing this kind of communication. There were, however, times when groups or individuals found it difficult to talk about this kind of communication and "reverted" to discussing intrascientific communication—that is, communication within the scientific community (such as publishing papers or presenting at conferences). This suggests that there are variations in terms of how accessible these discourses of public communication are within scientific cultures. In particular, it appears likely that the accessibility of discourses of communication is linked to a group's experiences: Those that had minimal experience of public communication activities are most likely, in discussion, to revert to a focus on internal scientific communication.

While there is a diverse range of talk about public communication used by scientists, this does not mean that there are no identifiable themes within their talk. In fact, there are several concepts that can be found repeatedly in the data and that appear to be important in scientific cultures. I turn now to examine these, first by looking at the mass of talk that deals with participants' ideas of the purposes and content of public communication.

Constructing Communication: Talk About Purposes and Content

Participants at times found it hard to express their thinking on particular aspects of communication—hence, as I have noted, a tendency to revert to talking about intrascientific forms of communication. However, this was rarely the case for discussion around their ideas about the purposes and ideal content of public communication; conversation on these topics tended to flow easily and to involve few hesitations. This was especially true for talk about what should be communicated. Two key themes came out of this talk: It is important to be relevant, and it is better to communicate "big ideas" or key principles than detailed research. Thus, in the extract below, Luke explains that the most important thing in public communication is to be relevant:

> Luke: Obviously the key thing about communication there is to tie into relevance. That has to be there at an early stage, otherwise you'll be lose- it doesn't matter how or what you say, if it's not clue- clued into people's experiences on a personal level, if . . . it means something to them, and it's going to be important or of some relevance to them, they can pick up on it.

As he describes it, relevance is essential: If you are not "clued into people's experiences on a personal level," in fact, you will lose your audience. Relevance as an important feature of communication was an almost universal point of discussion in the data, which in turn led, in some groups, to talk about exactly what was relevant. People are understood—as Luke's comments imply—to be interested in what affects them personally. Thus many groups focused on applications of science as an important part of what should be communicated. That this angle—of personally relevant applications—might be hard to find in some of the "more mundane" parts of science was much discussed.

Similarly, groups talked about the necessity of conveying "big ideas" rather than the details of their science: They would rather, for example, that people understood the reasons for or reasoning behind the work that they

were doing than the exact names of the enzymes they were studying. This was true both of general scientific content—the key concepts a field revolved around—and what we might call scientific process or, as Henry does in the extract below, "scientific principles":

> Henry: Er- but- you have to think what are the really important scientific ideas that you want to bring across. . . . So how can you get across like the really important kind of scientific principles like establishing cause and effect and controlling things.

Here Henry is not concerned so much with communicating scientific information as with concepts of process such as "cause and effect" and "controlling things." It seemed to be important to most groups to focus on such "big ideas" of science rather than the details of their own work or other scientific information.

In addition to these two key themes in what the content of communication should be, participants also spent time discussing what were the best modes for this content. A frequently used concept was that the ideal should be visual or interactive forms of communication: demonstrations, "activities" involving the audience, images, and the use of comedy were all suggested. This type of communication was held up in contrast to lectures or strongly text-based modes, which were considered to be ineffective and to not engage their audience. Bal, for example, argues below that demonstrations and visuals are "much more powerful" and will get a better response from their audience:

> Bal: I think people- people generally respond to pictorial me- well things you draw as well as demonstrations I think visual cues are much more powerful.

We might sum up talk around the best content for science communication, then, as it needing to be relevant, about the "big ideas" of science, and visually or interactively presented. This is already suggestive of purposes for science communication: presumably it is intended to be an effective transfer of these kinds of information. In addition to this, however, there is talk in the data that more explicitly explores what public communication is for. In fact, this is one area where there is an entire spectrum of different ideas present: stated motivations for communication range from the self-aware (personal benefits for the communicator) to the altruistic (society needs to know). Three themes are especially predominant, however, and are consistently brought up by participants. The first is that the purpose of public

communication is simply to "educate" people: This is the most frequent within this data and involves a constellation of closely related ideas. The exact language used is diverse, ranging from ideas of "convincing people of their role" to simply wanting to "make them understand" or "increase their awareness." All, however, share the basic concept of an education process, with scientific information being given to a deficient public (Gregory & Miller, 1998). This process is visualized as itself having further possible effects, for example creating—as in Lola's quote below—a more positive outlook toward science:

> Lola: Sometimes you have to talk more to other people because a lot of people are scared of science like about biotechnology, many people are scared and I think it's more because they don't know really the advantages of it. They always see the disadvantages of biotech-technology but never the advantages really. So you have to do something, so people are not so scared anymore.

Here Lola explains the need to "talk . . . to other people" because of their fear of science. This talking involves, she implies, an explanation of the "advantages" of technologies, such as biotechnology, that will lead to a straightforward acceptance of those advantages; she concludes by saying that after this process, the people involved will be "not so scared anymore." This notion—that education will lead to a positive attitude to science—can be concisely expressed as "to know science is to love it" (Turney, 1998) and is questionable at best (Bucchi & Neresini, 2002); not only is it key within this "education" framing, however, but it also underpins the two further common conceptions of the purposes and effects of public communication found in the data.

These are that communicating science will both help recruit people into science as a profession and inspire and interest the public generally in science. Both of these come together in Henry's comments below:

> Henry: I'm not sure what would be the main one [purpose]. I think there's several things. One is to inspire people and just make them interested and one of the side effects of that is that potentially good people are then interested in going into the subject.

Henry is talking about what he thinks are the purposes of doing public science communication. These purposes are multiple—he acknowledges that there are "several things"—and include inspiring or interesting people and, as a result of that, recruiting some of those people into science. This theme of recruitment

is surprisingly dominant within the discussions, with some participants seeing this as the main purpose of doing public communication:

> Boris: I see it more pragmatic- pragmatic, I think communicating is only to find- to the general public is to find recruitment.

In sum, then, we might say that the main purposes of public communication are understood as being to educate people and—through that—to inspire interest and to recruit individuals into science.

Before concluding this section on scientists' talk about the purposes and content of science communication, it seems important to note an overarching framework that encompasses all of the ideas I have discussed. This is that in all of the talk I have described—whether it is about the need for relevance or recruitment as a desired effect—communication is constructed as a one-way transfer of information. Public communication, in other words, is assumed to involve the transmission of science from the scientists to the public: There is no return flow of knowledge, but is rather about simply "telling people." The model of communication used is thus similar in structure to Shannon and Weaver's 1949 model (see Fiske, 1989; Gregory & Miller, 1998): we see communication imagined as involving a "packet" of scientific information of some kind, reception of this being unproblematic, and there being certain predictable effects in the recipient as a result. What we seem to have in the data is a silence around public voices: Any concept of two-way communication is generally Othered (to use Law's, 2004, phraseology) and made invisible. The idea of publics having a voice within the communication process is ignored, and communication is therefore silently constructed as being about what science has to say. The extracts above have illustrated this: in them, the scientific voice is the sole one considered or discussed.

Communication as Difficult or Dangerous

Despite this straightforward narrative of the communication process, public communication is also strongly constructed as difficult or dangerous, and as a negative experience for the scientists involved. Several aspects of this negative depiction come through in the quote from Luke, below:

> Luke: That's what's very difficult I think about very broad scientific communication, is the level that you pitch it at between actually saying the realities and the details of it, and being very glib, or very wa- hand-waving to the point

> of where actually it's not factually truthful, but it may be very whizz bang and glamorous, at one level, and it really is that level of finding the balance, that is so difficult, and why it's n- science communication is not normally done very well, or there's a full spectrum of how well it's done. I think that's what so- puts people off- and certainly would put me off, speaking to a very broad audience is that you're very much out there on a limb (*laughs*) and you don't know or it takes a lot of experience and maybe getting it wrong before you find that right balance of interest and truth (*laughs*).

Much of Luke's language is negative—note the repetition of "difficult," and phrases such as "puts people off" and "out on a limb." Communication is represented as a dangerous balance between "interest and truth": What makes public communication so hard, Luke is saying, is that the expert involved treads a fine line between a "glib" and uninteresting focus on "realities and details," which bores your audience, and being "whizz bang and glamorous" but not "factually truthful." An enormous and almost impassable barrier is thus constructed between science and a "broad audience." Luke is painting a bleak picture of both the public for science communication—who cannot deal with the detailed "truths" of science but require superficial special effects to hold their attention—and the communication process itself, which is conveyed to us as a hard, off-putting, frightening, and error-laden experience.

This negativity toward communication is a key theme within the data, even when public communication is itself seen as a worthwhile thing to do. The process is strongly constructed as a difficult one. It is seen as hard to be clear and understandable, and hard to be "interesting"; this, of course, links to the perceived need for relevance discussed above. Communication is difficult because it is hard to interest the public in your research if it is not directly relevant or applicable to them. Fiona, in the extract below, differentiates between different kinds of science in terms of how hard they are to communicate:

> Fiona: So it's easy when you're doing conservation to talk to the public about conservation, cos it's one of these topics that people like to hear about. It's less easy to talk about matrix modeling.

She argues that some things are easy to "talk to the public" about (conservation being her example); people "like to hear about" such things (which presumably have some special relevance or interest to them). On the other hand, it is harder to communicate more obscure forms of science in which people are not automatically interested.

In addition to public communication being described as difficult, the discussion data also shows it being constructed as a risky or potentially dangerous process. Much of this has to do with the public audience: communication needs to be "careful," it seems, because the public will readily misunderstand or misuse science. Thus in the extract below Luisa—who comes from a group involved in biomedical research—talks about the need for caution in what you communicate:

> Luisa: I agree . . . you've got to be careful about what you tell them as well because some- if you tell them there's research going on and you're looking into various aspects, they want to know exactly how long that's going to be then 'till you get a cure or some sort of treatment that's gonna help them out and often that's years and years away, so you've gotta be very careful about sort of how much information and the way it's put.

Caution is required because, it seems, public audiences may read too much into communications and expect too much from science: they want to know exactly when the research will be able to "help them out." Caution has to be exercised both over how any information is expressed ("the way it's put") and how much information is given. Complete transparency is understood as dangerous and communication construed as needing to be politic. Similarly, concerns were expressed in some groups about an excess of public access to scientific information (leading to, e.g., patients incorrectly self-diagnosing), or the availability of "incorrect" information. In scientists' talk, then, communication is a dangerous process not because of any inherent riskiness in talking about science or transferring information, but because it is communication to the public. The public's lack of discernment and inability to handle science correctly is what makes communication a dangerous process, and calls for scientists to above all be careful how and what they communicate. This, of course, leads us back to the understanding that public communication is difficult; pitching the information correctly and preventing a (willful?) public from misunderstanding is seen as an uphill struggle:

> Maryam: People do get bored about um sort of things- be- because they don't understand, so you can't really go into technical details so you really can't discuss about anything in relation to what you're doing. So it is really difficult to promote- you know to even discuss what you're doing with sort of the general public.

Public communication, then, is consistently constructed as a difficult and dangerous process for the scientists involved. In conjunction with the

previous point that public communication is overwhelmingly viewed as a one-way transfer of scientific information, this might be viewed as rather a depressing finding for those involved in encouraging or analyzing science communication. A "dominant model" of popularization (Hilgartner, 1990) appears alive and well, and—despite findings that scientists who engage in communication activities tend to enjoy them (Pearson et al., 1997)—participants in this study generally see public communication as, at best, a problematic process.

This is not, however, the full story. One of this study's key findings is of the presence of a range of—at times conflicting—discourses of communication within the talk of groups and individuals. Although constructions of communication as one-way and negative are dominant within the data, we also find more complex models and understandings of the communication process. I turn now to discuss these in more detail.

Competing Constructions: Communication as Positive, Complex, and "Debate"

While dominant discourses around public communication in scientists' talk seem to construct it as a negative and one-way process, then, there are also a range of competing—if minority—discourses in the data that view it rather differently. In particular I would like to examine three of these: communication as positive (in contrast to constructions of it as difficult and dangerous), communication as complex and context-dependent, and communication as "debate."

First, then, public communication can be described as a *positive* process: It is important and useful, and—as opposed to being almost impossibly difficult—it is possible. Contrast, for example, Ed's comments below with the earlier quote from Luke on the difficulties of public communication:

> Ed: I think it's important to talk about any research, really, you know. I think everybody wants to sing their own trumpet about what they're doing and why it's important, but just to tell the public wha- what's actually going off out there, and you know ex- explain it if you can explain it to a layperson, then you can explain to anybody I think really (*laughs*) It is important.

Luke's language gave us a sense of an ultimately negative process; here Ed is far more upbeat. He argues that public communication is important (he repeats the word three times), not just for especially "relevant" science but "any research." Not only is it important, but he understands it as a useful

process for science. It gives researchers a chance to talk about their work and "why it's important" (an opportunity to self-publicize, in fact); and the experience of explaining your work to laypeople gives you useful skills, ensuring that you'll later be able to "explain to anybody" what you do. Although we might note that there continues to be an understanding of communication as "tell[ing] the public," Ed's reasons for this seem slightly more complex than those we have previously seen; he doesn't mention the deficiencies of this public, but rather sees communication as informing them "what's actually going off" within science. Overall, then, we are given a sense of an important, useful, and perhaps even enjoyable experience. As Ed says, with rather mixed metaphors, "everybody wants to sing their own trumpet."

Ed's comments on wanting to inform the public of what's happening in science—suggestive of a responsibility to communicate—lead on to my second point, that communication may actually be understood in rather more complex ways than simply being for education and through a simple transfer of information. We also find models of communication as a highly context-dependent process and as being a responsibility that aims for public accountability. The purposes for communication may, in fact, be described not just as enabling accountability to the public (who pay for science), but also as justifying research being done or as empowering the public. Bal, for example, in the quote below, states a need for scientists to justify their work:

> Bal: Well I think scientists have to justify to some extent whether they should do research they're doing.

Similarly, Unwin sees one purpose for science communication as being empowerment for participation in democratic processes. Interestingly, he notes that this involvement is important because "political and ethical decisions" are not just for the scientists to make; he implies, in fact, that once "empowered," the public may actually be able to speak back to science:

> Unwin: Making people feel more at ease at it, making people feel that they can- that they're empowered to make decisions about it . . . you know that's another useful role for science communication, to help people be empowered to make the deci- the political and ethical decisions that are not just ours to make.

In addition to such constructions of science communication's purpose, we also find ideas of public communication as not being a straightforward homogenous process of information transfer, but rather as variable depending on context. This comes through particularly within discussion on the best way of

doing public communication: take, for example, this exchange from one of the groups:

> Ethan: Yeah it depends why you're trying to communicate something right if you're just communicating it-
> Kayla: And who to as well, I mean is it just the general public-
> Ethan: Mmmm.
> Kayla: -or is there like a specific- I mean if it was children or something like that-

Here Ethan and Kayla are emphasizing that there is no one "right" way of doing science communication: What you will do depends both on your exact purpose ("why you're trying to communicate something") and your audience ("who to"). Similarly, we have already seen another participant—Henry—acknowledge that there are multiple purposes for communication. Public communication, in this type of talk, becomes a complex and situated process that varies between localities, rather than a "one size fits all" mechanism applied indiscriminately.

Finally—and leading on from Unwin's comments above—we also find ideas of communication as debate in the data; science communication, in other words, is not solely constructed as a one-way process but may, in these minority discourses, be imagined as a two-way dialogue. These ideas surfaced within one group in particular, who engaged in a long discussion of the practicalities of a debate around certain topics. Tanya, within this discussion, expresses the "interest" of this kind of debate as giving the scientists a sense of what the public think:

> Tanya: But it would be interesting to have a proper debate though wouldn't it with the general public to talk about these sorts of issues and whether they think animal testing is something- or animal experimentation is something that they- they do approve of in certain circumstances or not.

In addition to being useful to scientists in helping them to understand public opinion, the talk around this issue also described the debate process as having some kind of impact on science: Public participants in such a debate might "come up with a view" that is useful to science or discuss the topic until they reach a "middle ground" for action. Such depictions of science communication are significant in that they have a far greater fit with current policy opinion on the role of science communication (Council for Science and Technology, 2007; House of Lords, 2000; The Royal Society and Royal Academy of Engineering, 2004) than the one-way transfer of scientific information described previously. It is important to note, however, that within this

data, even these discourses of debate are ultimately limited and constrained according to scientific perspectives. The discussion in which Tanya was involved, for example, also included the following exchange:

> Tilly: So is- would this be kind of an exercise to bring everybody round to- our point of view? (*laughter*)
> (*2 second pause*)
> Neil: Yes *(laughter)*

The group thus self-consciously reflected on what they would hope to get out of such a debate; although they paid lip service to the idea of having the "whole gamut" of views present, in practice they would hope that those present would be persuaded to their own points of view. Similarly, their discussion of who to engage in such a debate acted to limit the debate itself. They were keen, for example, to focus on "nonextremists."

In sum, then, this section has examined a range of more complex minority discourses around public communication within the discussion groups. Whereas dominant discourses constructed communication as a one-way process that was both difficult and risky, these kinds of talk depicted public communication in more positive terms and in more complex ways, including as context-dependent and as two-way. I move on now to draw together my discussion, and to reflect on some implications of the findings.

Discussion

This article has attempted to add to existing work on scientific constructions of publics (Burchell, 2007; Cook et al., 2004; Michael & Brown, 2000; Stilgoe, 2007) by adding a focus on public communication in scientists' talk. I have sketched out some of the key discourses around science communication to the public found within discussion groups held with scientists and engineers: we might understand the themes that I have identified as the "social voices" of communication found within scientific cultures.

A key point has been that there are a range of different discourses around public communication: we have identified several important narratives that occur frequently within talk. Examining such discourses around the purpose and content of public communication—finding themes such as the need for relevance and that "to know science is to love it"—I argued that these are overarched by a framework of one-way transfer of information. Taken along with the assumption that this transfer of information will unproblematically

"educate" the audience, it seems that the model of communication being used is one that is simplistic at best (Bucchi, 1996; Hilgartner, 1990; Locke, 2002; Wynne, 1991). Similarly, we saw that public communication was generally framed in very negative ways: it is seen as a difficult, perhaps impossible, task, as well as a dangerous one that requires extreme caution to prevent audiences from misunderstanding or misusing scientific information. Finally, however, I examined a range of minority discourses that presented public communication in rather different ways. We saw talk that constructed communication as a positive experience, as highly context-dependent, and—perhaps most significantly—as a two-way (though somewhat limited) debate.

Importantly, these types of talk are intermingled. Discourses of one-way and more complex communication appear in the language of groups and individuals—at times within the same turn or sequence of speech. Such "inconsistency" is to be expected; all talk is context dependent and contingent (Cameron, 2001; see also Gilbert & Mulkay, 1984, for a science-specific example). This suggests that a variety of "social voices" of public communication are in fact accessible within scientific cultures. Although the dominant models of one-way communication appear to be more readily available and frequently used, speakers may at times draw on minority discourses to describe public communication processes.[3] The data does suggest, however, some patterns in terms of the frequency that the different types of discourse are used. Although both overarching forms of discourse—dominant and minority—were present in all of the groups studied, minority discourses appeared more frequently in those groups with greater experience of public communication and of working with publics. Thus, for example, a group with close connections to patient groups and medical charities appeared to draw on more complex constructions of communication more frequently than a group doing similar research but with no such connections. Perhaps unsurprisingly, then, it seems that when scientists have closer contact with lay publics, their language use starts to shift to reflect more nuanced versions of these publics and communication to them (see Davies, 2007).

I would like to briefly reflect on two implications from my findings. The first is that—as readers will have observed—talk about public communication, while revealing much about the models of the communication process being used, simultaneously co-constructs the publics being communicated to. Although models of "the public" are not the focus of this paper,[4] it is important to note this co-construction: discourses of communication do not exist in isolation but are part of a "web" of social voices which also imagine, for example, publics and science (cf. Maranta, Guggenheim,

Gisler, & Pohl, 2003). This is not entirely unexpected, particularly if we consider the literature on the "deficit model" of the public. Although early accounts focused on the concept as a way of describing the public as "cognitive deficit" and ignorant (Wynne, 1991; Ziman, 1991), it rapidly became tied to a fuller story of both the public and communication (Gregory & Miller, 1998; Miller, 2001; Sturgis & Allum, 2004). Miller (2001, p. 116), for example, talked of the model in the following terms:

> Increasingly, the finger of guilt pointed toward what had become known as the "deficit model," which assumed "public deficiency, but scientific sufficiency." This model adopted a one-way, top-down communication process, in which scientists—with all the required information—filled the knowledge vacuum in the scientifically illiterate general public as they saw fit.

In descriptions such as these, a model of the public—as ignorant—leads on to a model of communication (as filling a "knowledge vacuum"). It is therefore not surprising that within this data the two concepts are also tightly tied together.

Although a full examination of the models of the public in use within this data is beyond the scope of this article, it seems important, then, to acknowledge that models of communication do imply particular characteristics of publics. What do the descriptions of public communication that I have identified suggest about the public? I noted dominant discourses of communication as one-way, as "education," and as difficult and dangerous: such discourses fit in with descriptions of "deficit model" communication (as in Miller, 2001, above) and imply a public which is indeed deficient and requiring education. In addition, descriptions of communication as difficult and dangerous add an extra layer to this cognitive deficit model, giving us a sense of a public that is not only ignorant but also unfit to handle science: Caution is required in public communication because publics are undiscerning, readily misunderstand, and, perhaps, willful in their dealings with scientific information.

The more complex discourses of communication that we examined, however, similarly have more complex models of publics implied within them. The description of communication as a context-dependent process, for example, acknowledges that science communication deals not with "the public" but with particular publics within local contexts. Ideas of public communication as debate, even more significantly, suggest that public groups may have knowledge of their own which could be useful to scientists. The public in this case, in other words, is not a knowledge vacuum but

an active and opinionated body. However, it is worth returning here to the point that these discourses of debate ultimately seemed, within the data, to be constrained and limited. These discourses do imply more complex models of the public than, say, the deficit model, but they remain bounded by a framework of the ultimate primacy of scientific knowledge. It appears that all the discourses of communication I have identified continue to function to—in Hilgartner's (1990) terms—shore up scientific authority, naturalizing a view of science as the "epistemic gold standard" (p. 520).

As a second point for reflection, I would like to return to the content of my preamble at the start of this article. In this I argued that understanding the understandings of scientists about public communication, as well as the public, is essential given the role individual scientists take in science communication in all its forms (whether these are "dialogue" events, outreach to schools, open days, or any other of the myriad formats that exist). Having surveyed the ways in which public communication is constructed within scientists' talk, what significance might my findings have with regard to scientists' roles in such communication activities?

A brief word of warning is necessary here: I have examined themes within talk about communication, not how those communication activities will actually be carried out. It would be naïve to assume a direct relation between what my participants say and what they will actually do (see Gilbert & Mulkay, 1984; Mulkay, 1981; Silverman, 2001). Rather, this research has identified some of the frameworks that scientists appear to use when talking about public communication. Many of these are expressed implicitly, as assumptions within talk (such as the dominant discourse of one-way communication). We might therefore suggest that they could be more powerful in shaping behavior than more explicit and self-conscious claims. This work leads us to anticipate certain behaviors or actions, then; to what extent these actually occur remains a question for future research.

Having noted the provisionality of any suggestions I make, then, what impacts might the discourses I have identified have on science communication practice? A key finding was the dominance of rather traditional discourses: of communication as one-way, as "education," and as struggling to engage an unreceptive public. As discussed, in many ways such discourses link to deficit models of publics. Given the dominance of these kinds of discourses in the data, we might anticipate that these models and understandings of public communication and the public will play a key role in shaping any public communication activities in which scientists engage. It seems likely, from this data, that much of the time scientists and engineers will simply assume that any public communication in which they are involved

is to be one-way and for the purpose of educating an ignorant public. Communication activities organized, framed, and run by those within science seem likely to draw on these discourses and understandings, and—more to the point—work would need to be done in exploring and changing such assumptions by those (inside and out of the scientific community) interested in utilizing more complex models of communication.[5] On a very practical level, then, we should not expect dialogue (House of Lords, 2000) to spring up automatically: Effort needs to be expended within scientific cultures to reframe key discourses of communication as two-way rather than one-way. Those interested in promoting dialogue, both as a policy tool (Parliamentary Office of Science and Technology, 2006; Wilsdon & Willis, 2004) and an informal communication activity (Davies, McCallie, Simonsson, Lehr, & Duensing, in press; Lehr et al., 2007; Reich, Chin, & Kunz, 2006) will need to ensure that all participants are coming to the process with a full understanding of the kind of communication involved.

This assessment could be construed as rather dispiriting for those involved in science communication; after 8 years of talk about "dialogue," "public engagement," and "science and society" (see, for instance, Council for Science and Technology, 2005; RCUK 2002), most talk by scientists about communication constructs it in a way more suited to the "traditional PUS" movement (Michael, 2002). However, a further key finding of this study is that there is diversity in the discourses of communication drawn upon. I have argued that there are more complex models of communication (such as debate or as context-dependent) present within scientific culture. these are currently minority discourses, but that they are present at all is encouraging. There is, it seems, competition to the "one-way education to a deficit public" model present within science. The task—again, for those with interests in promoting science-society dialogue—is to encourage and increase the accessibility of these more complex discourses of communication.[6] If this occurs, then it seems possible that scientists and engineers could go into public communication activities assuming not one-way communication and the sole primacy of scientific knowledge, but rather expecting a context-dependent, multiway debate that seeks to acknowledge all knowledge forms.

Notes

1. A small body of older, more biographical work does exist: examples are Goodell (1977) and, to some extent, Werskey (1978). A further exception is a 2000 report by MORI, funded by the Wellcome Trust. This survey-based work identified a broad sense of responsibility for

communicating scientific research, conceptions of a wide audience, and reports of time pressures limiting involvement in public communication. Pearson et al. (1997) identified positive attitudes toward communication processes *after* taking part in such processes. Overall, little work has specifically focused on the *talk* of scientists.

2. Specifically, research groups from biology, chemistry, physics, chemical engineering, environmental science, and medical science departments were interviewed.

3. Given that language relating to *both* straightforward and more nuanced views of public communication is found within the talk of particular individuals and groups, it is impossible to identify proportions of either of these subscribing to one view or the other. Overall, I can express the relative occurrence of these types of talk only qualitatively, in the language I have used to describe them: dominant models of public communication are indeed dominant within the discussions, whereas those discourses I have described as "minority" are present but very much in the minority.

4. See Davies (2008) for a full discussion.

5. That such more complex forms of public communication are generally more effective and productive I take as read. Although "dialogic" communication itself remains in many cases problematic (see Kerr, Cunningham-Burley, & Tutton, 2007, for example), plentiful research has indicated that one-way, "deficit model" communication is simply inaccurate in its expectations of how lay publics interact with science (Layton et al., 1993; Wynne, 1991; Ziman, 1991) and that, at the very least, more context-aware approaches are necessary (Gregory & Miller, 1998).

6. The start of the discussion implies one way of doing this: for scientists to have more contact with their publics. Such contact seems to increase the use of more complex—and realistic—models of communication and of the publics themselves.

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Sarah R. Davies has a BSc in biochemistry, a MSc in science communication, and a PhD examining "the public" of scientists' talk and public engagement events. Her publications include theoretical and empirical analyses of informal public dialogue events and descriptions of the complexity of scientists' talk about science and the public. Based at Durham University's Institute of Hazard and Risk Research, she is currently working on a project looking at lay ethics of nanotechnology.