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The Construction of Imaginaries of the Public as a Threat to Synthetic Biology

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Introduction

Scientific institutions and innovation-focused government bodies have identified public attitudes to synthetic biology as an obstruction to the field. This view is based on a perception that the public is (or will likely become) fearful of synthetic biology and that a ‘public scare’ would impede development of the field. Fear of the public’s fear of synthetic biology, which I characterise as ‘synbiophobia-phobia’, has been the driving force behind the promotion of public engagement and other activities to address ‘ethical, legal and social issues’ (ELSI). These activities have been problematic in two ways. Firstly, they are based on the discredited ‘deficit-model’ understanding of public responses to science, in which negative public attitudes towards science are thought to result from a lack of scientific knowledge. Secondly, they have taken for granted sociotechnical expectations put forward by scientific institutions. These promises of the field, and the tacit normative commitments embedded within them, have not been opened up to public appraisal.

In these ways, synthetic biology exemplifies many phenomena described by Welsh and Wynne (2013). This article analyses the ontological stakes in the work conducted by scientific institutions to conjure up imaginaries of publics with respect to synthetic biology. As synthetic biology emerges as a field of hope under threat from publics, how have science, publics and the relations between them become defined?

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The Public as an Obstruction to Public Benefit

Synthetic biology has been portrayed as an emerging field with great potential. For example, the UK Engineering and Physical Sciences Research Council (EPSRC) described it in 2009 as ‘a fast developing area of transformative science offering unique opportunities to deliver significant benefits in areas such as therapeutics, environmental biosensors and potentially novel methods to produce food, drugs, chemicals or energy’ (2009, p. 47). The same year, a report by the Royal Academy of Engineering (RAEng) stated that:

Synthetic biology is destined to become of critical importance to building the nation’s wealth. It has the potential to transform world industry in areas such as energy, health and the environment; to produce a new era of wealth generation; and create large numbers of new jobs. (RAEng, 2009, p. 9)

Based on such sociotechnical expectations, synthetic biology had been branded by the UK Department of Business, Innovation and Skills (BIS) as one of the ‘Eight Great Technologies for Great Britain’ that deserve government support in order to accelerate commercialisation (BIS, 2013). In a speech announcing this decision, Chancellor George Osborne stated that ‘they say that synthetic biology will heal us, heat [us] and feed us’ (Osborne, 2012). This concise embodiment of synthetic biology’s potential has since become a tagline for the field and has transformed into a firm promise. For example, an editorial in a special issue of *Nature Reviews Microbiology* devoted to synthetic biology began: ‘Synthetic biology *has been predicted* to heal us, feed us and fuel us’ (Anonymous, 2014, emphasis added).

This grand destiny for synthetic biology is, however, perceived to be in danger of being subverted by ‘public perceptions and fears’, identified as the field’s main ‘threat’ in the EPSRC’s SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis:

Public perceptions and fears of synthetic biology may obstruct research in this field, in a similar fashion to GM. This has been recognised by all stakeholders and public engagement and dialogue activities are in the process of being developed. (EPSRC, 2009, p. 46)

These two representations of the field—its potential to deliver grand benefits to society and its susceptibility to fearful publics—have been constructed concomitantly. Thus, somewhat incongruously, scientific institutions see ‘public attitudes’ as a major obstacle to the field that needs to be surmounted in order to deliver its ‘public benefit’. This is illustrated by this quote from the leading synthetic biology research centre in the USA:

The purpose of the workshop is to provide science practitioners with the skills and confidence needed to communicate with general audiences about the importance and potential of engineering biology. The Wilson Center, the OECD and others have stated that synthetic biology is still in uncharted waters of public opinion, but that public attitudes about this field could have a serious dampening effect on our ability to engineer biology for public benefit. (Synberc, 2014)

The earlier controversy over genetically modified (GM) crops is routinely cited as an important precedent, and in this context, campaigning NGOs are perceived as a major threat. This view is illustrated by Volker ter Meulen, Chair of a working group on synthetic biology for the IAP (the global network of science academies):

Synthetic biology is [...] controversial, and that is jeopardizing its promise. Environmental groups argue that it poses risks to health and the environment and have called for a global moratorium. We have been here before: exaggerated fears and uncritical acceptance of claims of the risks of genetic modification led to excessively cautious regulation and a block on innovation [...] given the precedent of how the issue of genetically modified crops were handled, many scientists are worried that some policy-makers will take unsubstantiated concerns of environmental groups at face value and impose cumbersome and unnecessary rules. (Meulen, 2014)

I have routinely encountered such views among scientific and innovation-focused government institutions, during a five-year immersion in the field of synthetic biology. Communication and public engagement initiatives are called upon to ensure that publics understand the potential of synthetic biology to contribute to societal benefits and that potential risks are not overblown. There is no recognition that the definition of societal benefits, and the way in which synthetic biology will contribute to them, might need to be opened up to deliberation. Supporters of synthetic biology advocate communication and dialogue, but not debate where people could disagree about what is at stake.

Synthetic Biology's ELSI-work

Interconnected Layers of Activities and Actors

Synthetic biology, in its current incarnation (Campos, 2009), is only about 10 years old but has already been subjected to a great deal of scrutiny in scientific and policy arenas. This has involved interconnected activities including: producing institutional reports on ethical, legal and social issues (ELSI); conducting

opinion polls and public dialogues; enrolling social scientists into research centres and projects; and constituting or consulting para-governmental advisory groups. I refer to these collectively as ‘ELSI-work’. Key players include academies of science and engineering, innovation-focused governmental and inter-governmental bodies (BIS, European Commission and OECD), research funders, pollsters, think-tanks and bioethics committees.

This article focuses on ELSI-work in the UK, where the phenomena described have been particularly evident. Some US initiatives are also discussed because their influence reaches out across the Atlantic. In addition, the iGEM competition plays an important role in the ‘cosmopolitanisation’ of synthetic biology, through ‘the social synthesis of aligning national R&D resources and actors with the global scientific community’ (Zhang, 2011). Competing undergraduate student teams are expected to conduct ELSI-work, so this is another arena where imaginaries of publics are conjured up, and assumptions about the threat posed are shared and consolidated. This is apparent, for example, in one of last year’s projects, entitled ‘gaining acceptance by overcoming fears’ (iGEM2014 Freiburg team, 2014).

Some social scientists working in the field of synthetic biology seek to distinguish their work from the dominant ELSI-framing described in this article (Balmer *et al.*, 2012; Rabinow and Bennett, 2012). Some excellent research is emerging from these scholars (e.g. Sara Aguiton, Andrew Balmer, Kate Bulpin, Jane Calvert, Luis Campos, Caitlin Cockerton, Emma Frow, Susan Molyneux-Hodgson and Sara Tocchetti), but this has had little effect on the way in which ELSI-work, including the enrolment of social scientists, is understood by scientific and innovation-focused governmental institutions.

Institutional Reports

The structure of institutional reports on synthetic biology tends to follow a similar structure. They first assert the promise of the field, then introduce technical aspects before turning to a fairly standard list of ‘issues’: biosecurity (the notion that people could misuse synthetic biology to create weapons), biosafety (potential harms caused by the intended or unintended release of organisms from laboratories and factories); and the creation of ‘artificial’ life forms (with these concerns typically qualified as ‘moral’, ‘ethical’ or ‘philosophical’). Intellectual property is also sometimes mentioned as a public concern with respect to the creation of monopolies, but more often with respect to the potential for patents to limit the development of the field.

The ELSI sections of these reports typically conclude with the need to ‘identify’ and ‘address’ ‘societal implications’. The involvement of social scientists, ethicists and philosophers, are called upon for this endeavour, alongside ‘early public dialogue’ (e.g. Royal Academy of Engineering, 2009, p. 9). This structure draws boundaries between the conduct of research and innovation, on the one hand, and

downstream social implications, on the other, and implies that the role of ethics, social scientists, and public engagement is relevant only to the latter. Moreover, the matter-of-fact tone used to state the promises of the field excludes them from social appraisal and denies the normative commitments embedded within them.

US Opinion Polls

In institutional reports, public concerns are defined by experts (including social scientist and ethicists). Two other mechanisms have been used to elicit public opinions more directly: opinion polls and focus groups. In the USA, the Wilson Center commissioned Hart Research Associates to conduct a survey that was repeated in 2008, 2009, 2010 and 2013. The survey design and interpretation of the results reveal a preoccupation with the supposed role of scientific information in shaping public opinion.

Thus, particular attention is paid to comparing the ‘initial’ ‘unaided’ view and the ‘informed’ view of the risks and benefits of synthetic biology, collected before and after providing respondents with a short definition of the field and examples of potential applications, risks and benefits (see Figure 1). The

After learning about synthetic biology, more move toward concern about risks than toward optimism about benefits.

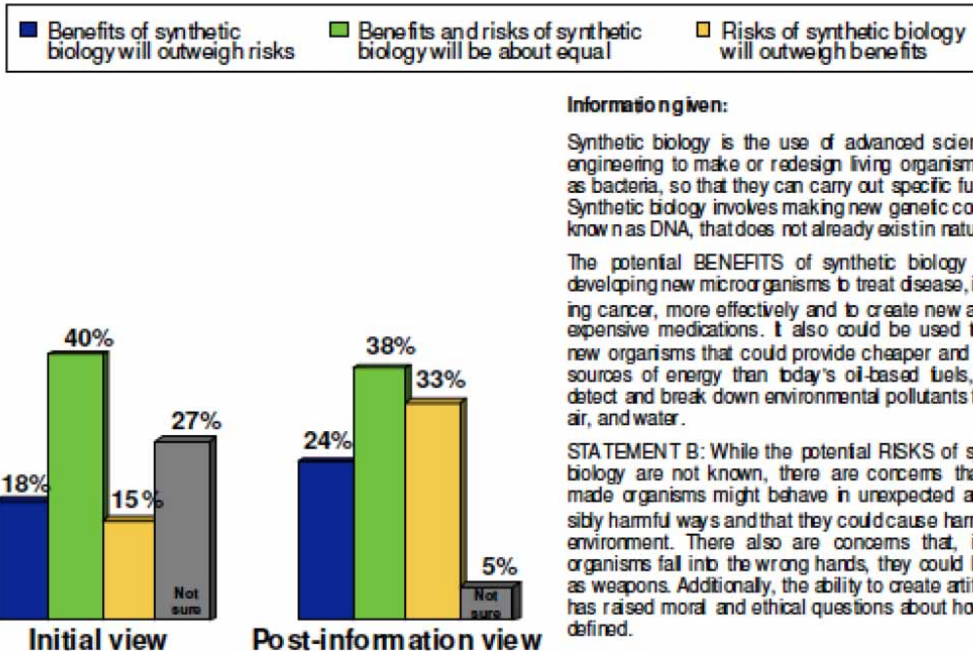


Figure 1. An eternally surprising result from surveys on public attitudes to science: more scientific information does not simplistically lead to more positive attitudes. *Source:* Hart Research Associates (2013).

expectation is that the ‘informed view’ will be more positive. Providing ‘the public’ with ‘knowledge of the science’ is seen as being important ‘now before it is framed by misimpressions, misinformation, or scepticism’ (Hart Research Associates, 2008, p. 2).

This belief endures even though decades of opinion polls have systematically failed to demonstrate a linear correlation between scientific knowledge and public attitudes, and reveal instead ambiguous relationships between these dimensions (e.g. Evans and Durant, 1995). The Hart Research Associates survey further confirmed these results: fewer respondents were prepared to say that they had no opinion when they were asked to appraise the risks and benefits of synthetic biology a second time, and the sample shifted slightly towards more negative appraisals. Similar results have been systematically reproduced in surveys on public attitudes to science, but appear to be perpetually surprising among scientific and governmental institutions. When this result was repeated, and became stronger, in the third wave of the Hart Associates survey, the ‘informed views’ were re-labelled ‘post-information views’.

The survey also asked respondents whether they believe ‘synthetic biology should move forward, but more research must be done to study its possible effects on humans and the environment’ or ‘A ban should be placed on synthetic biology research until we better understand its implications and risks.’ The question does not allow for ambiguity: respondents are expected to either support or oppose the field. But as the 2013 report explains, ‘a majority of adults support continuing synthetic biology research’, 61% said ‘move forward’ and 34% said ‘ban’, ‘despite’ the fact that there had expressed concerns in their previous answers (Hart Research Associates, 2013, p. 2). This result is interpreted as being surprising or inconsistent: How can respondents express concerns and still support the field?

Yet qualitative research has routinely revealed such ambivalence and explained how it can be interpreted as well-informed and rational (Marks, 2009). Overall, the Hart Research Associates survey defines public concerns according to the expectations of scientific institutions and then seeks to measure those concerns. It also predefines the kind of information that is supposed to be most relevant for people to form an evidence-based opinion without allowing publics to voice concerns that might be framed differently or to consider other kinds of information.

UK Dialogue

In the UK, scientific institutions avoided using opinion polls, in part because the framing problems discussed above have been acknowledged to some extent. Instead a ‘Dialogue’, commissioned by the Biotechnology and Biological Sciences Research Council (BBSRC) and EPSRC, was conducted in 2010 by the market research company TNS-BMRB. Focus groups were conducted with 129 people ‘recruited to reflect a wide cross-section of the public’. These were reconvened three times, for a total of 14 hours, and the discussions were structured

using insights from interviews with stakeholders. Compared to surveys, the qualitative methods used provide participants with more opportunity to challenge framings imposed by researchers, and the in-depth analysis in the report produced by TNS-BMRB revealed the same kinds of ambivalent and nuanced responses to science typically found through such research (Bhattachary *et al.*, 2010).

Interactive voting sessions were, however, also conducted ‘to track the public’s opinions over the day’ (TNS-BMRB, 2010, p. 9). Respondents were asked to say whether different categories of applications (medical, energy, bioremediation and food/crop) were ‘morally acceptable’, a ‘risk to the environment’, ‘useful for society’, and whether these applications ‘should be encouraged’ or are ‘not how we should approach the problem’. The same questions were asked at the beginning and end of the day, and participants could view the results instantly on a screen. This gave both the members of the public and the scientific experts present the impression that quantitatively measuring responses to these questions, and identifying any shift in opinions after deliberation, was a key feature of the exercise.

This interpretation was further consolidated when histograms presenting the results of these votes were included in the Dialogue report. Thus, among scientific and governmental institutions, the Dialogue was largely understood as an exercise to survey public attitudes, an impression also conveyed by the headline of the press release announcing the results: ‘A major new public dialogue activity on the public’s views and attitudes on synthetic biology has revealed that most people are supportive of the research but with conditions on how and why it is conducted’ (BBSRC, 2010).

Results from the Dialogue were reported as representing conditional support, but the conditionality expressed by members of the public was misinterpreted as a desire for more robust risk regulation and for consideration of ‘wider implications’, understood as downstream moral and ethical issues, separate from scientific aspects. Other kinds of public concerns revealed by the Dialogue were less well apprehended. These were well summarised in Bhattachary *et al.*’s report as ‘five central questions’ that emerged from the focus group discussions: ‘What is the purpose? Why do you want to do it? What are you going to gain from it? What else is it going to do? How do you know you are right?’ Like previous research on public responses to ‘emerging technologies’, these questions reveal that public concerns tend to focus on the process of research, rather than the products: Who sets the agenda? How? On what basis?

These results have, however, been construed as a request for individual scientists to demonstrate their laudable and non-profit-seeking intentions, and this has led to further pressure for researchers to imagine and highlight potential applications with seemingly obvious grand societal benefits when communicating with their funders or the public. This interpretation of the Dialogue results has

erased concerns expressed by participants about a lack of transparency and accountability in research processes.

Omnipresent Disembodied Publics

Publics are simultaneously omnipresent and absent in discussions about synthetic biology. They are omnipresent as disembodied, imagined, publics but absent as actual persons or organisations. Lay people or representatives of social movements have been excluded from inner circles of deliberation such as, for example, the UK Synthetic Biology Leadership Council (SBLC) or the US Forum on synthetic biology. Social scientists (such as myself) have been invited to sit on these committees and are sometimes referred to as representing the public in these arenas, but this is an identity that most of us would reject (Calvert and Martin, 2009). When publics have been present, it has usually been as outsiders, invited in for special occasions. For example, representatives from campaigning NGOs are sometimes invited to take part in debates at scientific meetings or public events; and invited publics were the core constituency for the UK Dialogue.

The disembodied public that is conjured up during discussions among scientific and governmental elites is typically conceived of either as an uncommitted member of the public who has no particular interest in the field or as over-committed activists who are portrayed as being intent on shutting down the field. When referring to the first category, the public (usually in the singular) is represented as a passive (unmobilised) and malleable entity, easily swayed by information. It is assumed that ‘sensationalist’ and ‘unscientific’ information from campaigning groups or the mass media will produce negative attitudes, and that adequate scientific information will produce positive attitudes. Mobilised publics, referred to as ‘activists’, ‘NGOs’ or ‘environmental groups’ are, on the other hand, portrayed as having entrenched views, and as terrifically, and terrifyingly, active. They are portrayed as being able to easily influence media representations of synthetic biology, and thus also the attitudes of the unmobilised public.

Both committed and uncommitted publics are perceived to be irrationally fearful of GM techniques *per se*, and this is assumed to be based on an a preoccupation with, and misunderstanding of, ‘naturalness’ (e.g. they do not realise that we have been manipulating nature since ancient times) and a lack of knowledge of the molecular basis of genetics (e.g. they do not even know that ordinary tomatoes contain genes). Both categories of publics are perceived to be made up of individuals who are concerned mostly about risks and benefits, defined narrowly as direct impacts on their own health or wealth from their consumption of products produced using genetic technologies. When members of either group ‘veers off’ to ‘talk about Monsanto and all that’, they are represented as being off subject and politically motivated. In this way, perceptions about the public become self-



Figure 2. When Evolva, a company that says it is using synthetic biology to produce vanillin, faced public controversy, it published a video that conjured up their imagined public. *Source:* ‘Eve explains fermentation’, video published by Evolva on 28/08/2014. Available at <http://youtube/y96w21HkaHQ>.

fulfilling: only concerns about the unnaturalness or narrowly defined risks of GM technologies are acknowledged as relevant. Other concerns are batted away.

In one case, supporters of synthetic biology have literally made up their imagined public. When controversy about vanillin produced by Evolva hit the headlines in Spring 2014, the firm produced a video portraying Joy, a woman who is initially suspicious of ‘tweaking natural yeast’ yeast used to produce vanillin (see Figure 2). Over the course of the three-minute video, a female scientist (Eve) explains to Joy that ‘people have been doing that to yeast for millennia’ and argues that Evolva’s product is more sustainable than vanillin produced from petrochemicals or vanilla extracted from orchid flowers. By the end, Joy is not entirely convinced but is willing to keep an open mind. Scientists dream of having such a conversation with members of the public—as they are imagined to be.

Good Versus Bad NGOs

Analysing the GM crops debate in 2001, Tait categorised motivations of stakeholders along two dimensions: ‘interest-based’ and ‘value-based’ (Tait, 2001). These dimensions were initially used to analyse the positions of a range of stakeholders including companies, scientists, farmers, consumer groups and environmental groups, but Tait and others have more recently applied these ideas mostly to organisations that campaign against particular technological developments. For example in 2012, Tait argued that the activities of an NGO coalition that had

produced ‘Principles for the Oversight of Synthetic Biology’ were rooted in an ‘ideologically based framing of the technology as inherently hazardous, based on negative conjectures with little relationship to actual evidence’ (Tait, 2012, p. 579).

Tait also presented this characterisation of ‘critical stakeholder engagement’ to an audience of potential applicants for funding from the UK Technology Strategy Board to help advance synthetic biology applications closer to commercialisation. In the related Powerpoint slide, she represented ‘uncommitted members of the public’ as the squeezed middle between interest-based and ideologically based organisations (Tait, 2013, slide 7). Tait argues that it is relatively easy to ‘deal with’ interest-based conflicts (by providing information, compensation and negotiation), but much harder to deal with ‘those based on values and ethics’.

Such views are widespread. The fact that Tait was appointed to serve as the only social scientist on the SBLC, as well as Chair of the SBLC’s Sub-group on Governance indicates that her views are well-aligned with powerful governmental and scientific institutions. Tait was also commissioned to draft a report on synthetic biology for the International Risk Governance Council (IRGC), which recommended that stakeholder engagement needs to ‘ensure that equal prominence is given to groups with interests in the development of the technology—for example patient groups in drug development’ in addition to ‘groups motivated by shared values’ (IRGC, 2010, p. 40).

These perceptions about campaigning NGOs have led to a search for organisations that could be expected to be ‘less extreme’ and that ‘we can talk to’. In this context, patient groups are considered good ‘interest-based’ NGOs, because they are expected to support drug development and reduced regulatory burdens for new medical treatments, on the basis that they can see direct benefits to themselves or individuals close to them. In this context, a frequently conjured up scientific imaginary of the public is the patient who is terminally ill (usually with cancer) and is therefore so desperate that they are prepared to ‘try anything’.

Yet empirical research with cancer patient advocacy groups reveals a diversity of approaches to drug development, regulation and the role of the pharmaceutical industry. In particular, there are differences in ‘how advocates attempt to balance the needs of individual cancer patients seeking access to experimental or new drug therapies with the needs of society (and future cancer patients) for robust evidence of a drug’s risks and benefits’ (Davis, 2014). The Genetic Alliance is at one end of this spectrum and is the only campaigning NGO on the SBLC’s Sub-group on Governance.

In one conversation that I witnessed, Oxfam was identified as a potentially good NGO to engage with, because it was presumed that it would be supportive of synthetic biology’s project to produce the antimalarial compound artemisinin more cheaply, by producing it in engineered yeast rather than extracting it from plants. In another, the World Wildlife Fund (WWF) was identified because it was expected to be sensitive to the argument that synthetic biology will lead to

more environmentally sustainable products. These discussions fail to recognise that organisations such as Oxfam or WWF have more sophisticated analyses of the causes of poverty, ill-health and degraded environments than those that typically pervade scientific institutions. They are therefore unlikely to unquestionably support synthetic biology applications presented as technological fixes for problems involving complex, inter-related social, economic and environmental factors.

For example, synthetic biology's Artemisinin Project has been a poster child for the field and is promoted as being able to prevent hundreds of thousands of deaths that occur every year from malaria in developing countries (Marris, 2013). The explicit aim of the project is to produce cheaper artemisinin-based combination therapies, but Oxfam has already argued that efforts to provide easier access to these drugs, without adequate diagnosis and supervision, will fail to bring increased health benefits—and is a 'dangerous distraction' from better strategies such as investing in community health (Oxfam, 2012).

The distinction between 'value-based' or 'interest-based' NGOs does not acknowledge the 'tacit, normative commitments' embedded within the discourse and behaviour of scientific institutions which are necessarily involved in public responses to dominant science agendas, as argued by Welsh and Wynne (2013, p. 542). Thus, organisations that campaign against current developments in synthetic biology are dismissed as anti-capitalists who oppose any profit-making endeavour. These representations fail to recognise that sceptical responses from publics—both mobilised and unmobilised—are often reactions to the *absence* of any mention of commercial purposes in public communication. Thus, public responses are misinterpreted as a negative response to profit-making *per se*, rather than to this lack of transparency. This misunderstanding of public responses perpetuates a vicious circle whereby public communication actively promotes grand societal promises, while minimising profit motives, thus generating more public alienation (Wynne, 2001).

Persistence of Public Acceptability as the Identified Problem

The persistence of a particular understanding of, and obsession with, public acceptability as a major obstacle for synthetic biology became apparent during work I conducted with Jane Calvert as a member of the group that produced the UK Synthetic Biology Roadmap. At first we were asked to work on a chapter entitled 'Acceptability'. We successfully proposed to shift the focus and the title of this chapter to 'Responsible Research and Innovation'. In line with our approach, the report ended up saying:

Although addressing health, environmental and security risks is important, this will not in itself lead to broad public acceptability unless innovation in synthetic biology is demonstrably directed towards:

- new products, processes and services that can bring clear public benefits including, but not limited to, employment, improved quality of life and economic growth
- solutions to compelling problems that are more effective, safer and/or cheaper than existing (or alternative) solutions. (UK Synthetic Biology Roadmap Coordination Group, 2012, p. 19)

However, in the final layout of the report, a prominent ‘Public acceptability’ sub-heading was inserted on this page. In the Executive Summary, the theme of this chapter was summarised as ‘the need for awareness, training and adherence to regulatory frameworks’. And in the short version of the recommendations, the only mention of ‘responsibility’ was with respect to the need to ‘Invest to accelerate technology responsibly to market’.

In these ways, our contribution was essentially erased. I have on several occasions heard the report represented as having concluded that public acceptability is a key obstacle for the delivery of the promise of synthetic biology and that this is the reason why it is necessary to address ethical and societal issues, conduct public engagement and/or implement ‘responsible innovation’. This understanding of what is at stake endures, despite the fact that the text that follows the ‘Public acceptability’ subheading explicitly sought to challenge it.

Conclusions

Analysing debates in the field of nanotechnology in the period 2000–05, Rip described how the GM case contributed to a ‘nanophobia-phobia—the phobia that there is a public phobia’:

... there is not only an exaggerated interpretation of public concerns—seen as an indication of fear, even phobia of the new technology. Such concerns and fears are also projected onto the public, even when there are no grounds. In other words, a folk theory about public reactions resurfaces again and again—even though the limited data available indicate appreciation of the new nano-ventures rather than concern. Thus, the concern of nanoscientists and technologists about public concerns (painted as a phobia about nano) drives their views, rather than actual data about public views. (Rip, 2006, p. 358)

Evidence presented in this article reveals that synthetic biologists and policy actors who support them exhibit a similar fear of public fear. This synbiophobia-phobia has been the driving force behind ELSI-work and has influenced its conduct. Avoiding a repeat of ‘what happened with GM’ is routinely mentioned as a key objective, and during these discussions, the shared assumption is that controversy is necessarily a bad thing.

Compared to GM crops, scientific and governmental institutions have employed strategies to deal with public concerns earlier in the development of the field of synthetic biology. A constellation of national and international organisations have been involved in interconnected layers of ELSI-work, but these have all incorporated similar scientific imaginaries of the public. The continual reaffirmation of misunderstandings about public responses across activities in different arenas further contributes to their crystallisation. As a result, they remain remarkably impervious to contrary empirical evidence. Despite an often-genuine desire to learn lessons from past experiences, fundamental misunderstandings about the nature of public concerns endure. Public concerns are to be surveyed (or more accurately *surveilled*) and their concerns are to be overcome rather than respected and responded to.

The discourse about ‘the public’ (still often referred to in the singular) that dominates the field of synthetic biology discussions reflects the same underlying epistemic and cultural framing that has pervaded controversies around GM crops and foods since the 1990s. The discredited ‘deficit-model’ is still influential. According to this model, public misgivings about science or its applications are assumed to stem from a lack of scientific knowledge (Marks, 2009). Members of the public are seen as ‘empty vessels, to be filled with understanding of science to avoid emotional reactions running riot’ (Rip, 2006, p. 357). Science communication is called upon to placate irrational and unwarranted public fears (Gregory and Miller, 1998). Public engagement is viewed as ‘a process of elicitation, a mechanism for extracting relevant opinions and incorporating them into the process of government’ (Lezaun and Soneryd, 2007). Public responses are considered to be ‘emotional, dependent, epistemically empty, gullible to manipulation’ rather than ‘questions about “our” scientific-institutional culture and its assumptions’ (Wynne, 2006). With respect to GM organisms, the ‘myths’ about public attitudes that I identified with colleagues in the 1990s endure (Marris, 1999; Marris *et al.*, 2001). In 1992, Brian Wynne characterised these beliefs about public attitudes to science as ‘misunderstood misunderstandings’ (Wynne, 1992). Twenty years on, and despite substantial empirical research that discredits those views, public responses to science are still widely misunderstood as misunderstandings about scientific knowledge.

Spokespersons for scientific institutions regularly complain that policy-makers ‘take unsubstantiated concerns of environmental groups at face value’, as ter Meulen put it. Yet they, and actors conducting ELSI-work, have taken unsubstantiated technological *promises* at face value. Grandiose claims are made about the ineluctable potential for synthetic biology to help tackle global health and environmental problems, and to contribute to the bioeconomy. These matter-of-fact statements about the hopes of the field then serve as the basis for ‘speculative ethics’ (Nordmann, 2007) and for the information provided to participants in opinion polls and public dialogues. They are not presented as issues that need to be explored by social scientists or subjected to public dialogue.

As a result, synthetic biology's ELSI-work has neglected key questions: Is accelerating commercialisation necessarily a contribution to the public good? Under what conditions can the desired anticipated benefits be realised? How do solutions provided by synthetic biology compare to alternatives, including alternatives that involve no cutting-edge science? Who has defined the problems that need tackling, and how? By excluding such questions, synthetic biology's ELSI-work has not acknowledged the 'normative social commitments, meanings and trajectories embedded in [the] scientisation of politics' (Welsh and Wynne, 2013, p. 543), yet these aspects are crucial to the concerns of both mobilised and unmobilised publics.

The synthetic biology community has been more proactive in its engagement with diverse communities than other fields and should be commended for this. But synthetic biology's engagement with publics has been rooted in synbiophobia-phobia, thus perpetuating a belief system that closes down, rather than opens up, the politics of knowledge and power in technology choice (Stirling, 2012). Instead of reconfiguring the terrain for inclusive participation, it has ploughed deeper furrows in already entrenched modes of managing controversy. The situation is already similar to GM as regards the behaviour of campaigning NGOs, scientific organisations and innovation-focused state bodies alike. Synthetic biology's ELSI-work has taken place early on, before commercialisation, but rather than helping to avoid a polarised controversy, this effort has laid the battleground for conflict among opposing groups when products begin to reach the market.

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