Starting off on the wrong foot: the public perception of nanotechnologies and the deficit model

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There are still relatively few empirical or theoretical studies on the public perception of nanotechnologies. Those that exist evince a recurrent concern that can be summed up as follows: the emerging sector of nanotechnologies must take care not to repeat the mistakes committed by biotechnologies.

Biotechnologies are cited here as a paradigmatic example because of their failure from the outset to take their social impact seriously. They consequently created the conditions for research in the sector to slow down, or in some cases, indeed, to come entirely to a halt.[2]

The expression 'social impact' usually refers—not necessarily jointly—to two aspects. On the one hand it serves to emphasize the potential risks to health, the environment, and society as a whole deriving from the development of biotechnological applications; on the other, it serves to emphasize the role of citizens—sometimes called 'users', or 'consumers', or simply 'the public'—in orienting the outcomes of technical-scientific innovation. Underestimation of these aspects (in particular the latter) by scientists, politicians, and business leaders has provoked mounting public hostility to biotechnology research and development, especially in the agro-food sector. The consequences are still evident today. If 37% of Europeans declare themselves wholly opposed to "developing genetically modified crops to increase the variety of regionally grown foods",[3] with the consequence that Europe and numerous member-countries have imposed severe restrictions not only on the marketing of GMOs but also on research into them,

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[2] M.C. Roco and W.S. Bainbridge (eds), *Societal Implications of Nanoscience and Nanotechnology*, Dordrecht, Boston, London: Kluwer (2001); S. Wood, R. Jones and A. Geldart, *Social and Economic Challenges of Nanotechnology*, Swindon: Economic and Social Research Council (2003); Royal Society, *Nanoscience and nanotechnology: opportunities and uncertainties*, London: The Royal Society (2004); M.D. Cobb and J. Macoubrie, "Public perceptions about nanotechnology: Risks, benefits and trust". *Journal of Nanoparticle Research* **6** (2004) 395–405; R. Grove-White, M. Kearnes, P. Miller, P. Macnaghten, J. Wilsdon and B. Wynne, *From Bio-Nano: Learning the Lessons, Interrogating the Comparison*, paper presented at Joint Conference 4S & EASST "Public Proofs. Science, technology and democracy", Paris, 24–28th August 2004.

[3] Eurobarometer SE 225, W 63.1, *Social Values, Science and Technology*, European Commission (2005).

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this is largely because insufficient attention was paid—especially at the beginning—to the possible reactions of public opinion. Thus free rein was given to the natural evolution of those reactions, or even worse, to their manipulation by environmentalist pressure groups and misleading media sensationalism.

In the case of nanotechnologies, the moral therefore seems very simple: the lesson must be learnt, and opportune initiatives must be pursued from the outset. Yet it is not at all clear what lesson should be learnt, and therefore what initiatives would be 'opportune'.

To simplify an ongoing debate fuelled by a large body of analysis and research, two main interpretations have been put forward on the causes of the current situation in regard to biotechnologies.

First, many commentators maintain that the opposition to biotechnologies is due to the combined action of three factors: widespread ignorance about the subject, an increasingly entrenched anti-scientific culture, and disinformation by the media. On this view, the majority of people are hostile to GMOs and the research connected with them because they do not possess the scientific knowledge necessary to make competent judgements, and because they are conditioned by an irrational rejection of science, in its turn sustained by ignorance. Both attitudes, it is alleged, are fuelled by media that are either badly informed or deliberately engaged in anti-scientific campaigns.

This interpretation is known as the 'deficit model': a lack of adequate information gives rise to judgements devoid of scientific foundation, and it generates irrational attitudes which prompt behaviour contrary to scientific good sense.[4] If the problem is framed in these terms, the solution can only be that of undertaking initiatives to make up the deficit: for example, increasing and improving the popularization of science; giving greater importance to science on educational curricula; and multiplying occasions to enhance the prestige of scientific culture. A public sufficiently educated in science, the argument goes, will assuredly be a public in favour of it.

However, there are good reasons and sufficient empirical evidence to doubt the accuracy of this interpretation. First the argument according to which criticism or outright rejection of science depends on a lack of knowledge is somewhat weak, and indeed controversial, if subjected to careful scrutiny. The case of biotechnologies is emblematic. It is difficult, for example, to argue that a lack of basic information about genetics produces hostility to GMOs when 75% of subjects with little knowledge believe that the genetic modification of fruit and vegetables is dangerous, while fully 64% of respondents with a high level of knowledge also deem it risky (Figure 1). There is a difference, certainly, but it is too small to show a causal nexus between scientific ignorance and hostility to GMOs.[5]

For that matter, how can one explain that almost two persons in every three with a good level of knowledge express marked concern and scepticism regarding GMOs?

Likewise, the ability of the media to orient opinions and behaviour in one direction or another certainly cannot be taken for granted. Numerous studies conducted over a wide variety

[4] B. Wynne, "Knowledges in Context", *Science, Technology and Human Values*, **16** (1991) 106–121; B. Wynne, "Public Understanding of Science", in S. Jasanoff et al. (eds), *Handbook of Science and Technology Studies*, Thousand Oaks-London-New Delhi: Sage (1995) 361–89.

[5] M. Bucchi and F. Neresini, "Biotech remains unloved by the more informed". *Nature* **416** (2002) 261.

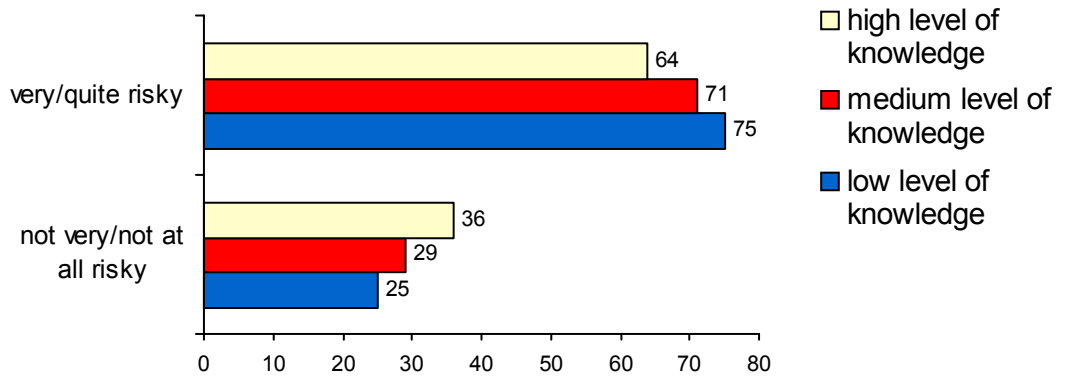

Figure 1. Perception of risk associated with the genetic modification of fruit and vegetables in relation to knowledge level.[6] (% values on n = 899; $p < 0.05$).

of areas have still not produced a definitive answer. If anything, many researchers instead maintain that the effects of the media operate within an already-existing structure of social relations, and it is these social and cultural factors that play a central role in shaping opinions, attitudes and behaviours.[7] The media therefore tend to reinforce already-existing beliefs and habits. Moreover, the attention of researchers has concentrated on the medium to long time scale, which has induced them to conclude that the effects of the media are exerted mainly at the level of social systems, rather at the individual level, through the attribution of importance to particular issues,[8] and the diffusion of very general interpretative frames, often taking the form of images and metaphors.[9] To return to biotechnologies, it has been shown for example that if exposure to science in the media (i.e. the reading of articles on science published in newspapers and magazines, and the watching of television programmes on scientific topics) is related to opinions about the genetic modification of fruit/vegetables to make them more parasite-resistant, one finds that the former has a decidedly modest impact on the latter.[10]

In fact, the percentage of those who believe that this biotechnology application is useful and risk-free increases—as one would expect—with the level of exposure to scientific content in the media. However, even among those most exposed to such content, more than half still believe that the production of genetically modified fruit and vegetables is pointless (52%), and even more believe that it is risky (59%).[11]

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[6] The data are from Bucchi M., Neresini F., Pellegrini G., 2005, *Biotecnologie e opinione pubblica in Italia – 2004*, Observa, Comitato Nazionale per la Biosicurezza e le Biotecnologie, www.observa.it.

[7] D. McQuail, *Mass Communication Theory*, London: Sage (1987).

[8] M.E. McCombs and D.L. Shaw, "The Agenda-Setting Function of the Press". *Public Opinion Quarterly*, **36** (1972) 176–187.

[9] In the caae of genetics, for example, see J. Turney, *Frankenstein's Footsteps. Science, Genetics and Popular Culture*, New Haven and London: Yale University Press (1998) and J. Van Dijck, *Imagenation. Popular Images of Genetics*, New York: University of New York Press (1998).

[10] M. Bucchi and F. Neresini, "Biotech remains unloved by the more informed". *Nature* **416** (2002) 261.

[11] M. Bucchi, F. Neresini and G. Pellegrini, Biotecnologie fra innovazione e responsabilità. Secondo Rapporto su Biotecnologie e Opinione Pubblica in Italia, www.observa.it (2002).

Give that numerous studies have shown the inconsistency of the assumptions shared by the deficit model with the nineteenth century conception of science popularization, and that they have demonstrated the fallaciousness of the 'media-knowledge-attitudes' causal chain,[12] it is evidently necessary to explore other possible interpretations, and to develop research in other directions.

For example, serious consideration could be given to the idea that the resistance to biotechnologies seems to be derived to a considerable degree from the currently perceived absence of adequate and publicly accountable procedures for the governance of scientific and technological innovation.[13] According to this view, there is largely unsatisfied demand for public opinion to be involved in decisions concerning crucial biotechnology issues. The existence of such demand is clearly documented by research,[14] and by the success of public participation initiatives undertaken through various forms of deliberative democracy (consensus conferences, scenario workshops, citizen's panels).[15] Moreover, it can be shown that a lack of adequate public involvement fosters negative attitudes to biotechnologies—for example by pointing out that the risk associated with GMOs is perceived most strongly by those who press for a significant influence on biotechnological research to be exerted by the general public.[13]

Consequently, rather than increasing commitment to communication as a one-way process, it instead seems necessary to invest in participation, reconfiguring communication between scientists and citizens as a dialogue between peers rather than as a strategy of top-down persuasion. The institutions most closely concerned with relations between science and society, moreover, stress that "information provision has to aim at more that just 'educating' the public as a presumed means of avoiding controversy […]; in particular because people resent or resist attempts at direct manipulation, greater knowledge does not necessarily bring greater acceptance of risks, and one-way communication without genuine dialogue about science issues may not address people's wider concerns".[16]

And in any case, continuing to interpret public attitudes with a causal model which conceives them as the mechanical product of communication and knowledge is not very useful.

There are therefore good reasons for arguing that, if we are to learn from the biotechnologies affair, we must not once again end up in the blind alley of the deficit model.

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[12] B. Lewenstein, "Science and the media", S. Jasanoff et al. (eds.), in: *Handbook of Science and Technology Studies*, Thousand Oaks: Sage (1995) 343–359; M. Michael, "Comprehension, Apprehension, Prehension: Heterogeneity and the Public Understanding of Science", *Science Technology & Human Values*, **27**(3) (2002) 357–78; B. Wynne, , "Public Understanding of Science", in S. Jasanoff et al. (eds), *Handbook of Science and Technology Studies*, Thousand Oaks-London-New Delhi: Sage (1995) 361–89.

[13] M. Bucchi and F. Neresini, "Why are People Hostile to Biotechnologies?" *Science* **304** (2004) 1749.

[14] M. Bauer and G. Gaskell (eds), *Biotechnology – the Making of a Global Controversy*, Cambridge: Cambridge University Press (2002).

[15] See, among others S. Joss and S. Bellucci (eds.) *Participatory Technology Assessment. European perspectives*, Westminster: The University of Westminster (2002); G. Rowe and L.J. Frewer, "A Typology of Public Mechanisms". *Science, Technology & Human Values* **30**(2) (2005) 251–90.

[16] "Nanoscience and nanotechnologies: opportunities and uncertainties", p. 66, London: Royal Society and the Royal Academy of Engineering (2004). See also the Recommendation no.8 in Health and Consumer Protection Directorate General, 2004, Nanotechnologies: a preliminary risk analysis, European Commission, Brussels.

An exemplary case

However, remaining trapped in the logic of the deficit model is not a remote possibility.[17] For example, the following chart (Figure 2) appeared in a recent issue of *Technology Review*.

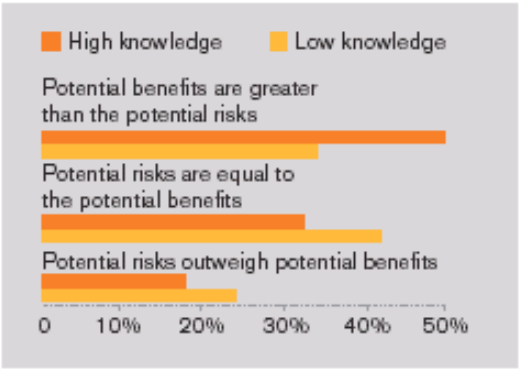

Figure 2. Perception of nanotechnology risks and benefits in relation to respondent's knowledge.[18]

In the commentary, one reads that "not surprisingly, public fears are directly correlated with the amount of knowledge that people have about nanotechnology: the less knowledge, the more fear."[19]

That this contrived interpretation of the data is dictated by the assumptions of the deficit model can be easily demonstrated. It is true that a larger percentage of people with less scientific knowledge see more risks than benefits in the development of nanotechnologies, compared with people who have greater knowledge. But it is equally clear that the percentage difference between the two groups is very small (just 6%), and that in any case one person in every five with greater knowledge believes that the risks outweigh the benefits. Conversely, although it is mainly the most knowledgeable subjects who emphasise the potential benefits, one certainly cannot ignore the fact that so do too fully 34% of those with scant knowledge, and that this optimism is not shared by fully 50% of people with good knowledge.

Also the authors of the article from which these data are taken reach the conclusion that the level of knowledge is not significantly correlated with assessment of the risks/benefits associated with nanotechnologies.[20] This is an obvious revision of their previous statement that "when the risks versus benefits data are examined by respondents' level of knowledge about nanotechnology, it is clear that greater knowledge is associated with the more positive perceptions of risks and benefits".[21] It may be that this assertion prompted the views expressed by the author of the summary published in *Technology Review*, but the fact remains that "the effects we reported earlier for […] knowledge are apparently caused by different respondent characteristics and attitudes".[22]

[17] S. Wood, R. Jones and A. Geldart, *Social and Economic Challenges of Nanotechnology*, Swindon: Economic and Social Research Council (2003).
[18] Technology Review, June 2005, p. 31.
[19] S. Lawrence, "Nanotech grows up", *Technology Review*, June 2005, p. 31.
[20] M.D. Cobb and J. Macoubrie, "Public perceptions about nanotechnology: Risks, benefits and trust". *Journal of Nanoparticle Research* **6** (2004) 402.
[21] *Ibid*., p. 398.
[22] *Ibid*., p. 402.

Nevertheless, there is still the serious risk of assuming an unproblematic relationship between the role of communication and technology acceptance,[23] where 'communication' stands for 'the channel through which knowledge is transmitted'.

Concluding remarks

Abandoning the deficit model in order to take full advantage of the lesson learnt from the biotechnologies affair opens the field for other lines of inquiry, although the form that they should take is as yet unclear.

In the background to policy processes one discerns a certain consensus on the view that experimentation with new methods to involve the public in decision-making should be backed by analyses able to assess their strengths and weaknesses. Whilst we may take the need to invest in participation for granted, a great deal of research and reflexion still remains to be done if we are to understand the true potential of the solutions adopted and subject them to further verification. There is no doubt, in fact, that the initiatives in deliberative democracy undertaken to tackle the issues raised by techno-scientific innovation have limitations, although they also hold out interesting prospects.[24]

There is even greater space for research on developments in the public debate, not least to take advantage of the currently favourable situation. The fact that sizeable sections of the population are still today excluded from discussion on nanotechnologies—according to recent figures, at least 40% of the population of Europe and at least 52% of that of the United States[25]—means that the public debate has not yet begun, even though media coverage is constantly increasing.[26, 27]

The lack of a thorough public debate underlines the crucial importance of this phase, a sort of 'zero time' where it is possible to observe which interpretation yardsticks common people

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[23] S. Wood, R. Jones and A. Geldart, *Social and Economic Challenges of Nanotechnology*, Swindon: Economic and Social Research Council (2003).

[24] D.H. Guston, "Evaluating the First U.S. Consensus Conference: The Impact of Citizens' Panels on Tele-communications and the Future of Democracy". *Science, Technology & Human Values* **24**(4) (1999) 451–482; G. Rowe and L.J. Frewer, "Evaluating Public Participation Exercises: A Research Agenda". *Science, Technology & Human Values*, **29**(4) (2004) 512–56.

[25] Eurobarometer SE 225, W 63.1, *Social Values, Science and Technology*, European Commission (2005); M.D. Cobb and J. Macoubrie, "Public perceptions about nanotechnology: Risks, benefits and trust". *Journal of Nanoparticle Research* **6** (2004). The qualification 'at least' is necessary because surveys tend to overestimate involvement in public discussion on any issue, owing to the well-known tendency of respondents to give what they think are socially acceptable answers for the interviewer. On the other hand, comparing the replies given in Europe and the United States to the same question ("Do you think nanotechnology will improve our way of life in the next 20 years"), the percentages of 'don't knows' were respectively 53% and 35% (Gaskell et al., *Public Understanding of Science* **14** (2005) p. 83).

[26] A. Andersen, A. Petersen and S. Allan, *Nanotechnology in the news: representing the risk*, paper presented at Joint Conference 4S & EASST "Public Proofs. Science, technology and democracy", Paris, 24–28th August 2004.

[27] G. Gaskell, Eyck T. Ten, J. Jackson, G. Veltri, , "Imagining nanotechnology: cultural support for technological innovation in Europe and the United States". *Public Understanding of Science* **14** (2005) 81–90.

use when they have to handle a techno-scientific 'object' still little known and at the moment not under discussion.

We could greatly benefit from better understanding of the system of social processes concerning techno-scientific innovation, setting a benchmark for the future against which the likely developments of public attitudes towards nanotechnologies can be compared.

The importance of this opportunity becomes clear when one considers that in the case of a moot innovation—such as, again, in biotechnologies—the analysis of attitudes suffered from a lack of appropriate knowledge about the situation before the public debate took on the extent and pitch that we know. Those who have encountered this problem have tried to cope with it by, for example, rebuilding the previous situation by means of a media study.[28] However, it is clear that this is only a makeshift solution, with numerous drawbacks, mainly the difficulty of deeming the media debate to be a faithful representation of public opinion.

What is certain, however, is that this large number of people at present excluded from the debate on nanotechnologies and devoid of information will rapidly form an opinion when they must take up a position on the matter. And, as documented by numerous studies on social representations,[29] they will do so by relying on previously-acquired metaphors, images and cognitive schemata.

In this sense, the biotechnologies affair is not only an emblematic case from which researchers and policy-makers can learn lessons, but also an important precedent on which people can draw to adopt interpretations and criteria already employed in the past. It is for this reason, too, together with those outlined above, that the study of the public perception of nanotechnologies may benefit greatly from analysis of the interpretative apparatuses that will presumably be used when the public debate on nanotechnologies begins.

[28] J. Durant, M. Bauer and G. Gaskell (eds), *Biotechnology in the Public Sphere*, London: Science Museum (1998).

[29] R.M. Farr, and S. Moscovici, *Social Representations*, Cambridge: Cambridge University Press (1984); M. Bucchi, *Science and the Media*, London – New York: Routledge (1998).