Scientists worry about some risks more than the public

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A comparison between two recent national surveys among nanoscientists and the general public in the US shows that, in general, nanoscientists are more optimistic than the public about the potential benefits of nanotechnology. However, for some issues related to the environmental and long-term health impacts of nanotechnology, nanoscientists were significantly more concerned than the public.

In previous controversies surrounding emerging technologies, such as nuclear energy and food biotechnology, scientists, in most cases, perceived lower risks associated with these new technologies than the general public or the journalists covering these stories. These findings seem to hold in both the US and Europe[1,2,3], and most recently, an exploratory comparison of a quota sample of 375 lay people and a convenience sample of 46 experts in Switzerland suggested that the same pattern is beginning to emerge for nanotechnology as well[4].

However, two large-scale systematic data collections in the US now show that the dynamics surrounding risk perceptions of nanotechnology among members of the general public and nanoscientists shape up to be much more complex than for previous issues. In particular, historical patterns of the difference between the perceptions of scientists and the general public of risks may be reversed for nanotechnology.

We collected survey data from both lay individuals and nanotechnology scientists. Both surveys used questions with identical wording, providing a unique opportunity for systematic comparisons across two large-scale, national data sets. The first data source was a general population telephone survey of 1,015 US adults; the second data source was a mail survey of 363 nanotechnology scientists and engineers. The fieldwork was conducted from May to July 2007 for the public opinion survey, and from May to June 2007 for the scientist survey (see Methods).

Not surprisingly, scientists were generally more optimistic about the benefits and less concerned about the risks of nanotechnology than the general public. For example, scientists were more optimistic about the potential for nanotechnology to lead to breakthroughs in medicine, environmental cleanup or national defence (Fig. 1a). Members of the general public, in contrast, were more concerned about potential drawbacks of nanotechnology than scientists, including the potential loss of privacy or adverse economic impacts (Fig. 1b).

However, scientists expressed more concerns than the general public about two areas of potential risks: more pollution and new health problems as a result of nanotechnology. This makes nanotechnology unusual among emerging technologies in that scientists working directly with the technology express stronger concerns about specific potential risk areas than the general public does.

These differences in risk perceptions between scientists and the general public for nanotechnology can be explained to some degree by how the issue has evolved, both in scientific circles and in the public debate. In particular, the fact that scientists are more concerned about new health problems and potential pollution than the general public should not be too surprising for at least two reasons.

First, there has been an ongoing debate in science and policy circles about a lack of systematic nano-related risk research in both academia and business[5]. Although many of these discussions were initially driven by specific toxicological concerns, similar concerns are now being voiced more broadly. In 2006, for instance, the Royal Society and the Royal Academy of Engineering in the UK recommended an expansion and standardization of research on the environmental, health and safety (EHS) impacts of nanomaterials[6]. Similarly, concerns about these have been the subject of public hearings in the US, organized by the Food and Drug Administration and, most recently, the Environmental Protection Agency.

Second, and somewhat related, interest groups in the US have pushed for specific regulations and safety procedures for new nano-enabled products. For

example, in a letter dated November 22 2006, the National Resource Defense Council lobbied the Environmental Protection Agency to regulate products containing silver nanoparticles under the Federal Insecticide, Fungicide, and Rodenticide Act. As a result, Amazon.com and Sharper Image removed from their websites all references to nanotechnology in descriptions of products that contained silver nanoparticles (such as Fresher Longer food containers). These changes went largely unnoticed by the general public[7].

The reasoning behind the strategies by some of these interest groups, of course, is to set the agenda among policy makers and other scientific elites, and ultimately to shape policy. Ironically, all these efforts take place without much media attention and without large-scale involvement of the public[8]. As our data show, one result is that health and environmental concerns are not at the forefront of most people's thinking. This is not to say that scientists are necessarily right and the public wrong in their assessments, and neither is it to say that other concerns that scientists and the public share, such as privacy, should be neglected. But it does suggest that, similar to findings from earlier research[9,10], public attitudes toward nanotechnology continue to be shaped by predominantly positive media frames[11] and what Gaskell *et al.* have called a culture of technological optimism in the US[12].

We do not mean to suggest, either, that the public should be more alarmed about environmental or health-related risks associated with nanotechnology than they currently are, or that concerns among scientists are simply an outcome of agenda-building efforts by interest groups or policy makers. Rather, our findings show a gap in risk perceptions among scientists and the general public that — regardless of its origin — is indicative of serious communication deficits.

The relatively low levels of attention that health and environmental risks of nanotechnology have received in mass media[11], therefore, provide industry and university scientists working in this area with a unique opportunity to take a leadership role in engaging the public in a meaningful dialogue about nanotechnology. And we strongly echo the argument of Currall *et al.*[13] that "now is the time to educate the public aggressively with facts about the risks and benefits of nanotechnology".

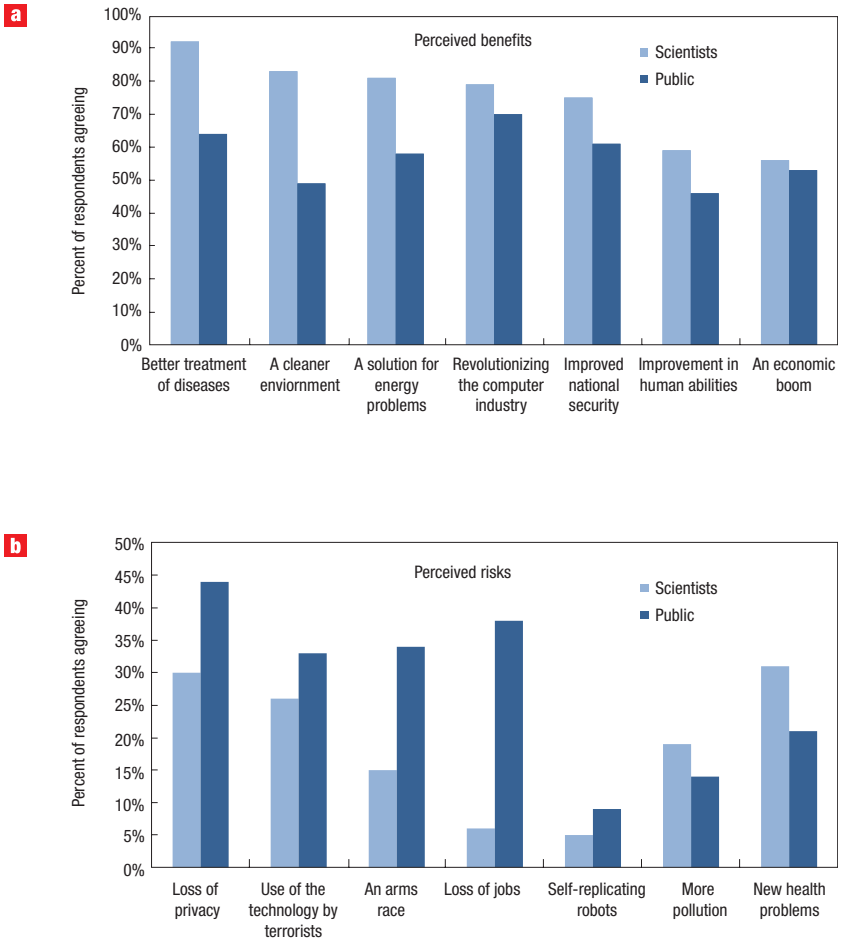

Figure 1 Perceived risks and benefits of nanotechnology. Scientists are more optimistic than the public about the potential benefits. They are also more concerned about environmental and health risks, but not other risks. **a**, Scientists (pale blue columns) were significantly more likely than the general public (dark blue) to agree that nanotechnology may lead to "new and better ways to treat and detect human diseases" or to "new and better ways to clean up the environment". **b**, Members of the general public, in contrast, were more concerned about five of the seven potential drawbacks of nanotechnology explored in the survey, such as the "loss of personal privacy because of tiny new surveillance devices" or the loss of "more US jobs". However, scientists were more concerned than the public about the potential of nanotechnology to lead to "more pollution and environmental contamination" and "new human health problems".

In fact our research shows that industry and university scientists are among the handful of groups the public trusts the most for information about nanotechnology — much more than governmental bodies, regulatory agencies and news media. Nanotechnology may, therefore, be one of the first emerging technologies where academia and business have the ability to reach out directly to a public who trusts the information they provide. Ironically, nanotechnology may also be the first emerging technology for which scientists may have to explain to that public why they should be more rather than less concerned about some potential risks.

METHODS

The first data source was a general population telephone survey of 1,015 US adults (AAPOR RR-3: 30.6%)[14]. The fieldwork was conducted from May to July 2007, and the approximate margin of error was ±3%. In order to minimize systematic non-response, we invested significant time and effort in call backs and refusal conversions.

The second data source was a mail survey of 363 nanotechnology scientists and engineers that was administered in three waves, following Dillman's Total Design Method[15] (AAPOR RR-3: 39.5%). The survey was based on a rigorous

sampling design that identified first authors and contact authors of more than 90,000 nanotechnology publications indexed in the ISI Web of Knowledge database between January 2005 and July 2006. (See ref. 16 for background on this method).

In order to construct our target sample, we compiled names and detailed contact information for a complete list of the roughly 1,000 US scientists (first or contact authors) whose nano-related work was cited five times or more in the publication database. By focusing on the most highly cited and most active scientists within the nanotechnology field, we were able to capture opinions from scientists with an established track record in the field of nanotechnology, rather than from scientists in unrelated disciplines who happened to publish on a nanotechnology-related topic during the timeframe outlined in our sampling frame. Given that many of the graduate students who were listed as authors on papers in our sample had moved to other labs or institutions by the time the survey went in the field, it was difficult to reliably identify contact information for many of them. The small number of students who were listed as lead or contact authors were therefore excluded from the sample. The fieldwork was conducted from May to June 2007. The approximate margin of error was ±5%.

Both surveys were conducted by the University of Wisconsin Survey Center. Additional methodological details for both studies are available from the corresponding author.

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