NANOTECHNOLOGY AND SOCIETY

New insights into public perceptions

Research into public perceptions of nanotechnology is becoming more rigorous as increasingly complex theoretical models are developed and tested by social scientists.

Steven C. Currall

During recent years, a burgeoning community of social science researchers has developed an understanding of how the public perceives emerging technologies such as nanotechnology. This issue contains three papers by social scientists that describe the 'state of the art' in this field and provide fresh thinking on the factors that drive public perceptions of nanotechnology. Such research is important because, ultimately, perceptions will determine if nanotechnology is accepted or rejected by the public. These three papers are distinctive because they mark a substantial advance in the range of theoretical factors considered to affect the public's perceptions and attitudes towards nanotechnology.

The elaboration of theory is vital for the development of a coherent body of research literature on public perceptions of nanotechnology. Research is advancing from description (how familiar the public is with nanotechnology and how the public perceives its risks and benefits) to theoretical models in which various predictors (such as cultural values, religiosity and social norms) influence public attitudes. Understanding of such predictors is vital because we can then make theory-based forecasts of how future shifts in these factors will subsequently lead to changes in public attitudes towards nanotechnology.

What are the main findings of the three studies? On page 87 of this issue, Dan Kahan of Yale University and colleagues have provided the most systematic empirical analysis so far of whether greater familiarity with nanotechnology results in positive attitudes[1]. Based on research in the US, they find that greater familiarity with nanotechnology does not automatically lead to more positive attitudes, but rather to a polarization of positive or negative views.

In exploring this polarization effect, Kahan and co-workers showed that, when exposed to new information about nanotechnology, study participants who held personal values characterized as 'hierarchical-individualist' showed more positive views of nanotechnology, compared with people holding 'egalitarian-communitarian' values, who showed more negative views. Values such as hierarchical-individualist and egalitarian-communitarian are emblematic of what Kahan and co-workers refer to as the cultural-cognition thesis, which is "the tendency of people to base their factual beliefs about the risks and benefits of a putatively dangerous activity on their cultural appraisals of these activities". They also find that culture can have a dual effect: cultural predispositions influence one's exposure to information about nanotechnology (for example, those with pro-technology values will seek information about nanotechnology), and they also provide a perceptual filter that leads people who are positive about nanotechnology to become more positive (and those who are negative to become more negative) as new information about nanotechnology is received.

On page 91 Dietram Scheufele and co-workers at the University of Wisconsin-Madison and Arizona State University explore the impact of personal values, attitudes and information processing, on perceptions of nanotechnology by examining the possibility that religious beliefs (that is, the importance to which one ascribes 'religious guidance') may serve as an important component of the value system that people use when evaluating the desirability of emerging technologies[2].

Given substantial heterogeneity across the US and European countries with respect to the religiosity of citizens, Scheufele and co-workers showed a "significant negative correlation between religiosity and agreement that nanotechnology is morally acceptable". Importantly, this finding held when they controlled for other factors such as trust in scientists, knowledge about nanotechnology and media coverage of science. The general pattern of findings was consistent across both individual- and country-level analyses.

Both research groups would agree that the values they studied are simply a subset of the overall value set that citizens use to make sense of emerging technologies, and that other values are also relevant. For example, Amar Bhide of Columbia Business School has discussed cross-national comparisons of consumers' values[3]. In particular, he suggested that US consumers might be relatively more 'venturesome', and that this might make them more sympathetic to new technologies such as nanotechnology.

On page 95 Nick Pidgeon of Cardiff University and co-workers in the UK and US took a different tack[4]. With the aim of elucidating the influence of contextual factors, such as institutional and regulatory, they conducted deliberative workshops about different applications of nanotechnology in Cardiff, UK and Santa Barbara, US. The workshops were designed for participants who did not know a great deal about nanotechnology and provided an opportunity to explore the reasons for different reactions to this technology. (It is also possible to measure the familiarity of participants with nanotechnology via survey data, and incorporate this into regression models as control variables — as was done by Scheufele and co-workers.)

Pidgeon and co-workers found that participants in the UK workshop were more sensitized to community, national and international implications of nanotechnology, whereas those in the US workshop showed greater technological optimism and consumerism. The two applications discussed in the workshops were health and energy, and the differences in attitudes to these were greater than the differences between the US and the UK. Examining specific applications and/or commercial products based on nanotechnology, as opposed to nanotechnology in general, is an important direction for additional work[5,6].

Like researchers in science and engineering, social scientists conduct research that emphasizes descriptive analysis, theory development and theory testing, or some combination of the three. Pidgeon and co-workers used descriptive and qualitative techniques to identify factors that are important in the public's perception of nanotechnology, which can now be used to develop theories that can be tested in further research. Their work can be described as inductive, because it involves generalizing from the specific case of nanotechnology to general patterns

Box 1 | Major survey studies of public perceptions of nanotechnology.

The work of the groups led by Kahan[1], Scheufele[2] and Pidgeon[4] builds on previous research dating back to 2002. In this box, survey studies are described in terms of three features: (1) descriptive analyses, inductive theory development or deductive theory testing; (2) methodology and data; (3) use of experimental or statistical control. Experimental control refers to researchers' control (manipulation) of the information to which the study participants responded. Statistical control refers to the use of statistical methods (such as multiple regression), after data were collected, to hold constant potentially confounding variables. Deliberative studies emphasizing public discourse methods are not included in this table for reasons of brevity.

Kahan *et al.*[1] Cultural cognition of the risks and benefits of nanotechnology (2009).
Deductive theory testing. Quantitative analysis of online survey data from US respondents. Use of both experimental and statistical control.

Scheufele *et al.*[2] Religious beliefs and public attitudes towards nanotechnology in Europe and the United States (2009).
Deductive theory testing. Quantitative analysis of telephone survey data from US respondents and face-to-face interviews of citizens of 12 European countries. Use of statistical control.

Pidgeon *et al.*[4] Deliberating the risks of nanotechnologies for energy and health applications in the United States and United Kingdom (2009).
Descriptive analyses and inductive theory development. Data based on transcriptions of workshop participants who were a quasi-representative sample of citizens in one geographical location in the UK and one in the US. Qualitative comparisons; neither experimental or statistical control.

Siegrist *et al.*[5] Laypeople's and experts' perception of nanotechnology hazards (2007).
Descriptive and deductive theory testing. Pencil-and-paper survey of quota sample of laypeople and non-random sample of technical experts in Switzerland, Austria and Germany. Use of statistical control.

Currall *et al.*[6] What drives public acceptance of nanotechnology? (2006).
Descriptive analyses and deductive theory testing. Online survey and random samples of telephone survey participants in the US. Use of both experimental and statistical control.

Hart Associates[8] Report findings based on a national survey of adults (2006).
Descriptive analyses. Representative samples of telephone survey respondents in the US. Neither experimental nor statistical control.

Gaskell *et al.*[9] Social values and the governance of science (2005).
Descriptive analyses. Representative samples of survey respondents in the US, Canada and European Union. Neither experimental nor statistical control.

Scheufele & Lewenstein[10] The public and nanotechnology: How citizens make sense of emerging technologies (2005).
Deductive theory testing. Quantitative analysis of telephone survey data from US respondents. Use of statistical control.

Cobb & Macoubrie[11] Public perceptions about nanotechnology (2004).
Descriptive analyses and deductive theory testing. Random sample of telephone survey participants in the US. Use of statistical control.

The Royal Society and The Royal Academy of Engineering[12] Nanoscience and Nanotechnology: Opportunities and Uncertainties (2004).
Descriptive analyses. Workshops in two geographical locations and one representative sample of interviewees in UK. Qualitative and quantitative analyses. Neither experimental nor statistical control.

Bainbridge[13] Public attitudes towards nanotechnology (2002).
Descriptive analyses. Non-random online survey. Neither experimental nor statistical control.

of public perceptions of technology. The groups led by Kahan and Scheufele, on the other hand, were more deductive in that they drew heavily on existing ideas from the psychology literature to derive hypotheses, which they then empirically tested using statistical inference techniques. All three groups also mentioned the impact of media coverage of nanotechnology on public sentiment — a topic that has also been explored by Sharon Friedman and Brenda Egolf of Lehigh University[7].

So, how does this latest work compare to previous research on public perceptions of nanotechnology? Box 1 provides a summary of major survey studies in the field, including the three papers in this issue. Research literature on the public perceptions of nanotechnology is maturing and becoming more rigorous, as increasingly complex and nuanced theoretical models of the factors that drive public sentiment about nanotechnology are subjected to empirical testing. Importantly, social scientists also have a further obligation to translate their technical research findings into language that is directly useful to others. Based on a deepening understanding of predictors of public perceptions, scientists, policymakers and businesses will therefore be better positioned to anticipate trends that will dictate how the public reacts to new scientific developments and commercial products based on nanotechnology. ❐

Steven C. Currall is in the Faculty of Engineering Sciences, University College London, London WC1E 6BT, UK and at the London Business School, London NW1 4SA, UK.
e-mail: scc@ucl.ac.uk

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