Predicting adherence to the deficit model: Research I scientists‘ perceptions of how lay individuals form attitudes toward nanotechnology

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Abstract

This study shows that scientists’ attitudes toward the social sciences plays a role in their perception of how people form attitudes toward nanotechnology. With science becoming increasingly complex, effective communication of science is more important than ever. Central to any communication process is an understanding of the intended audience, including their attitude toward the issue at hand and how they came to form that attitude. Scientists are key players in science communication, and many tend to think that knowledge is a major influence in the formation of lay individuals’ attitudes toward science, an idea called the “knowledge deficit model.” However, communication research shows that value predispositions and cues from the media (among other explanatory variables) are stronger predictors of public attitudes toward science than knowledge. Through a survey of full time, tenure-track and tenured scientists at an R1 university, I investigate the extent to which scientists adhere to the knowledge deficit model when thinking about how non-scientists form attitudes towards nanotechnology. The data was analyzed using hierarchical regression. A positive attitude toward the social sciences predicts moving away from the knowledge deficit model; that is, the more positive a scientists‘ attitude toward the social sciences, the more likely they are to move away from the knowledge deficit model. These findings strongly support furthering the incorporation of empirical social science research into any program with the goal of improving scientists’ interaction and communication with non-scientists. Future research may

include further investigating the role that scientists' attitudes toward social sciences play in relation to their adherence, or lack of adherence, to the deficit model.

Introduction

The rapid advancement of scientific research means that it is increasingly difficult to fully understand the societal implications of science and technology. The emergence of nano-bio-info-cogno technologies, for example, poses new and difficult questions related to their ethical, legal and social impacts, which are largely unknown and unprecedented. These impacts mean it is more important than ever for citizens to be able to make sense of decisions about science and technology, which makes clear, effective science communication from all players in the science research process absolutely necessary.

There are several models that describe how audiences process scientific information and form attitudes. At one end of the spectrum is the low-information rationality model, which assumes that people are cognitive misers, who use as little information as possible to make a decision, and satisfiers, who use just enough information to make a decision (Popkin, 1994). At the other end is the knowledge deficit model (hereafter called "deficit model"), which assumes that lack of support for an issue stems from a lack of information (Sturgis & Allum, 2004). In this model, effective science communication consists of sharing knowledge and information. There is little empirical evidence for the deficit model (Allum, Sturgis, Tabourazi, & Brunton-Smith, 2008), so many communicators and communication researchers have moved away from it as an explanation of how audiences make decisions and form public attitudes.

However, it is generally accepted among communication researchers that most scientists assume deficit model mindsets, and think that if non-scientists knew more about science, they would be supportive of scientific endeavors (Besley, Oh, & Nisbet, 2012; Besley & Tanner, 2011; Cook, Pieri, & Robbins, 2004; Davies, 2008; Gregory & Miller, 1998; Kurath & Gisler, 2009; Weber & Word, 2001). This deficit model mindset is problematic because it not only underestimates the complexity of decision-making, but also overstates the objectivity of scientific information (Weber & Word, 2001). Realistically, when scientific findings enter the world beyond the discipline-specific

journal, meaning is constructed, largely by the individuals consuming the information (Fiske & Taylor, 1991).

This deficit model mindset also leads scientists to believe the public communication to be a one-directional transmission of knowledge (Brossard & Lewenstein, 2010; Davies, 2008). Often scientists' approach to public communication is to provide lay individuals with scientific information, because, as Davies (2008) observed, they often employ the frame that "to know science is to love it" when engaging in outreach activities. In Brossard & Lewenstein's analysis of three models of public communication in the outreach setting—contextual, public engagement, and lay expertise—they find that the deficit model underlies most outreach efforts, regardless of the theoretical approach (2010). Moving away from the deficit model approach is essential to improving the efficacy of outreach efforts in fostering support for science. There is little quantitative evidence identifying scientists' adherence to the deficit model, which leads me to propose the following research question: **To what extent do scientists at a R1 university adhere to the deficit model when thinking about how public attitudes toward nanotechnology are formed?** In order to fully explore this question, it is necessary to explore what might underlie a deficit model mindset. What makes a scientist likely to adhere to the deficit model, despite the vast amount of research against its efficacy in explaining how public attitudes are formed? Perhaps part of the explanation comes from the hierarchy of the sciences, and how it manifests in scientists' own minds. As described by an editor of *Nature*, "it is the conventional wisdom in the biological and physical sciences, and within research agencies, that the social sciences are, well, 'soft,' and lacking in methodological rigor" ("In praise of soft science," 2005). There is plenty of anecdotal evidence of this conventional wisdom (for example, see Wilson (2012); see Cole (1983) for a comprehensive overview of the history of the hierarchy, and empirical investigation into the legitimacy of the stratification). Because research public attitude formation processes is within the discipline of social science, I expect that scientists' attitudes toward the social sciences to affect perceptions of how the public forms attitudes. This expectation is stated more specifically in the following hypothesis: **The more positive scientists' attitudes toward social science are, the less**

likely they are to adhere to the deficit model when thinking about controversial science issues.

Methods

To address this research question and hypothesis, I conducted a survey at a large Midwestern university in the U.S. of fulltime tenure-track and tenured faculty engaged in scientific research (N=1306, with 36.9% in biological sciences, 34.8% in physical sciences, 28.3% in social studies/social sciences). The survey questionnaire assessed scientists' perceptions of the climate of opinion surrounding nanotechnology, as well as scientists' perceptions of how public attitudes are formed, and was grounded in qualitative analysis of interviews conducted with a subsample of those surveyed.

The research questions and hypothesis were addressed using hierarchical regression with independent variables entered in the assumed causal order (Cohen & Cohen, 1983). The seven independent variables included in each analysis are gender, discipline, age and years since Ph.D., religiosity, political ideology, and, most important to this study, attitudes toward social sciences (index is composed of 2 variables that measure how rigorous the respondent thinks social science is, $r = .37$, $p < .01$). The dependent variable is an index measuring scientists' perceptions of the importance of the knowledge deficit model in the formation of public attitudes (an index composed of 3 variables that measure how important respondents think the role of knowledge is in attitude formation, Cronbach's $\alpha = .70$ and mean inter-item correlation = .43). Because of the small sample size, and because this study is exploratory, the alpha level for this study is .10.

Results

The survey response rate was 20.5%, and as a whole, the respondents reflected the university population of tenure-track and tenured scientists in terms of discipline and gender. Three significant variables significantly predicted movement away from the deficit model in the context of nanotechnology: biological sciences discipline (relative to the physical sciences outgroup), religious guidance, and attitude towards social sciences

(Table 1). The model significantly explains a 6.9% of the variance in moving away from the deficit model in the context of nanotechnology (R^2 = 6.9%, F(7, 208) = 2.21, p < .05).

To measure the scientists' adherence to the deficit model, an index was created. The deficit model index is on a 5-point scale from -2 to 2 where a score of -2 means full adherence to the deficit and a score of 2 means rejection of the deficit model. The mean score of the standardized deficit model variables indicates that on average, scientists lean slightly toward adherence the deficit model (*M* = -0.31, *SD* = 0.61). However, the frequency of scientists adhering to the deficit model differs depending on discipline.

The hypothesis that a positive attitude toward social sciences significantly positively predicts not adhering to the deficit model in this context, is supported (β = 0.13, p < 0.10; Table 1). Additional predictors include discipline and religiosity. Compared to physical scientists, biological scientists are more likely to think that knowledge plays a major role in how public attitudes toward nanotechnology are formed (β = -.19, p < .05; Table 1). Religiosity negatively predicts not adhering to the deficit model when thinking about how the public forms attitudes toward nanotechnology (β = -.13, p < .10; Table 1).

Table 1
Predictors of moving away from the knowledge deficit model when it comes to how the public forms attitudes toward nanotechnology

	Model 1 *β*	Model 2 *β*	Model 3 *β*
individual characteristics			
gender (male = 1)	-0.02	-0.02	-0.01
age + years since Ph.D.	-0.08	-0.08	-0.09
biological sciences	-0.16 **	-0.17 **	-0.19 **
social sciences	0.03	0.02	-0.02
incremental R^2 (%)	4.00 *		
value predispositions			
religious guidance		-0.13 *	-0.13 *
political ideology		0.03	0.06
incremental R^2 (%)		1.40	
attitudes			
attitude toward social sciences			0.13 *
incremental R^2 (%)			1.40 *
total R^2 (%)			6.90

Cell entries are final standardized regression coefficients for Blocks 1 through 3.
*p < 0.10, **p < 0.05

Discussion

This study found that on average, scientists lean more towards the deficit model than not, which aligns with the generally accepted idea that scientists think that more scientific knowledge creates more public support for science more (Besley et al., 2012; Besley & Tanner, 2011; Cook et al., 2004; Davies, 2008; Gregory & Miller, 1998; Kurath & Gisler, 2009; Weber & Word, 2001). The finding that scientists with more positive attitudes toward social sciences are more likely to de-emphasize the importance of knowledge in public attitude formation falls in line with Weber and Word (2001)'s idea that the deficit model mindset is closely related to underestimating how complex people's decision making processes are.

Limitations

Before discussing these findings in more detail, there are several limitations to this study. First, because of the small sample size, I chose to use accept p-values </= .10 as significant. However, using this p-value minimizes the probability of committing a Type II error, the error that theoretically I am more likely to commit (Agresti & Finlay, 2009). Also, though the survey response rate (20.5%) is within an implied acceptable range for the social sciences, it is still low compared to the ideal situation. The non-response bias may be so high (79.5%) largely due of the nature of the population sampled: full-time tenure-track and tenured faculty members at a high level research institution have a heavy workload among teaching, research and service responsibilities. Additionally, this is not a random sample of scientists at the university; respondents self-selected into the survey. Any inference made, then, to the scientists is potentially compromised by an unknown and unanticipated systematic bias. Considering that each broad science discipline—biological, physical and social—was fairly accurately represented in the sample, I do not think this is the case; however, it is still possible. Considering the length of the survey, it is also possible that there is some underlying characteristic of the tenacious scientists who did complete it that may have led to a systematic bias in the responses. Despite these limitations, valuable insights can be drawn from this analysis.

Deficit model and the science hierarchy

Scientists' acceptance of a hierarchy of the sciences, with "soft" science at the bottom, is well documented. These results contribute to detailing the effects of acceptance of that hierarchy and attitudes associated with it. Attitude toward social science has not been taken into account in previous research regarding scientists and the knowledge deficit model. Since this study focused on only one controversial science issue, interpretation of these results is in some ways very narrow. The relationship between scientists' attitudes toward social sciences and adherence to the deficit model presents a challenge, namely that science communication training which presents social sciences research might be encountering, in some scientists, a bias against the social sciences. This bias may make it difficult for some scientists to move away from the deficit model. Addressing this bias may lead to more positive attitudes toward the social sciences, which in turn may lead to more scientists moving away from the deficit model, and further downstream, to more effective public outreach practices.

Complications

However, scientists' moving away from the deficit model perspective might not lead to more effective public outreach practices. The risk of attempts to increase efficacy of scientists' public communication efforts by moving scientists away from the deficit model is that scientists might, instead of engaging in more effective outreach efforts, opt out. Besley et al. (2012) show that scientists' holding a deficit model perspective is one of the strongest predictors of their valuing and participating in public outreach activities, which are often themselves rooted in the deficit model (Brossard & Lewenstein, 2010). The implications of scientists not adhering to the deficit model may include a de-valuing and lessening engagement in public outreach practices.

Conclusion

The two main findings are that on average, scientists tend to accept the knowledge deficit model, regardless of discipline; and that a positive attitude toward social sciences significantly predicts scientists' moving away from the deficit model when thinking about how public attitudes toward nanotechnology are formed. These results suggest that

exploring the link between scientists' attitudes toward social scientists and their perceptions of public attitude formation processes would be valuable to science communication scholars. Future research should include both a nationally representative sample of researchers, as well as examine the link perception of public attitude formation processes and public outreach values and practice.

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