`

Report:

Cultural Cognition and Nanotechnology Risk Perceptions: An Experimental Investigation of Message Framing

Conducted by the Cultural Cognition Project at Yale Law School

Dan M. Kahan
Yale Law School

Douglas Kysar
Yale Law School

Donald Braman
George Washington Law School

Paul Slovic
Decision Research

Geoffrey Cohen
University of Colorado

John Gastil
University of Washington

[RELEASE DATE]

Research Supported by
National Science Foundation, Grant SES 0621840
The Project on Emerging Nanotechnologies
Woodrow Wilson International Center for Scholars
The Oscar Ruebhausen Fund at Yale Law School

The **Cultural Cognition Project at Yale Law School** is a group of scholars from Yale and other universities interested in studying how cultural values shape the public's risk perceptions and related policy beliefs. In research funded by the National Science Foundation, project members are using the methods of various disciplines—including social psychology, anthropology, communications, and political science—to chart the impact of this process and to identify the mechanisms through which it operates. The Project also has an explicit normative objective: to identify democratic procedures that enable society to resolve culturally grounded differences in belief in a manner that is both congenial to people of diverse cultural outlooks and consistent with sound public policymaking. For more information about the Project, log on to http://research.yale.edu/culturalcognition/.

The **Project on Emerging Nanotechnologies** is an initiative launched by the Woodrow Wilson International Center for Scholars and The Pew Charitable Trusts in 2005. It is dedicated to helping business, government and the public anticipate and manage possible health and environmental implications of nanotechnology. For more information about the project, log on to www.nanotechproject.org.

Cultural Cognition and Nanotechnology Risk Perceptions: An Experimental Investigation of Message Framing

Cultural Cognition Project at Yale Law School

Dan M. Kahan
Yale Law School

Douglas Kysar
Yale Law School

Donald Braman
George Washington Law School

Paul Slovic
Decision Research

Geoffrey Cohen
University of Colorado

John Gastil
University of Washington

Introduction and Summary of Conclusions

What will science reveal about the risks and benefits of nanotechnology? What conclusions will members of the public form? The study of *cultural cognition*—the tendency of individuals to interpret information about risk in a manner congenial to their self-defining values—suggests it would be a mistake to assume the answers to these questions will the same. Indeed, previous experimental studies, conducted by the Cultural Cognition Project (CCP) in conjunction with Project on Emerging Nanotechnologies (PEN), have identified various dynamics that impel persons of opposing values to polarize when exposed to balanced and accurate information on nanotechnology risks.

The most recent study in this series investigated of the power of *information framing* to accentuate or mitigate such cultural polarization. Major findings include:

1. Framing matters. The beliefs individuals form when exposed to balanced information on the risks and benefits of nanotechnology are significantly affected by the salience of different nanotechnology applications, including its use in the manufacturing of consumer goods, its use in facilitating environmental protection, and its use to enhance national security.

2. Risk-mitigation framing can backfire. Paradoxically, framings of nanotechnology that emphasize its potential to mitigate especially alarming risks *unrelated* to nanotechnology—such as arsenic in ground water or biological weapon attacks—can enhance the perception that *nanotechnology itself* is risky. The aroused anxiety that such framings produce apparently spills over to nanotechnology and crowds out the message that nanotechnology can make society safer.

3. Framing effects are culture specific. The impact particular framings have on nanotechnology risk perceptions depends on individuals' cultural identities. If a particular nanotechnology application *threatens* a group's cultural values, its members will form a higher

estimation of the risks and a lower estimation of the benefits of nanotechnology generally than if the application *affirms* that group's values.

4. Framing can aggravate cultural polarization. If *one and the same* application threatens one group's values and affirm another's, making that application salient will accentuate culturally polarized interpretations of balanced information. For example, commercial production of consumer goods has positive connotations for persons who revere competitive market behavior and negative ones for those who resent such behavior. As a result, the latter will see nanotechnology as more risky, the latter as less risky, when they are made conscious of the use of nanotechnology to produce consumer goods. Making salient the government's use of nanotechnology to *regulate* commerce and industry has exactly the opposite effect on these groups.

5. "Green to gold" is not a silver bullet. In theory, it should be possible to construct an information frame that affirms diverse cultural values simultaneously, thereby mitigating cultural polarization and promoting open-minded deliberation. We considered whether emphasizing the use of nanotechnology to create market opportunities for firms that produce devices to clean the environment would have this effect. It did not.

The Cultural Cognition of Nanotechnology Risks

"Cultural cognition" refers to the tendency of persons to conform their factual beliefs about the risks and benefits of a putatively dangerous activity to their cultural appraisals of these activities (DiMaggio 1997; Kahan, Slovic, Braman & Gastil 2006). Simply stated, it is much easier, from a psychological point of view, to believe that behavior one finds noble is also socially beneficial, and behavior one finds debased is dangerous, than vice versa (Douglas 1966; Guttierez & Giner-Sorrola 2007). Public opinion researchers have identified competing cultural values as the source of disagreement about numerous contested risks—from nuclear power (Peters & Slovic 1996; Jenkins-Smith 2001) to global warming (Leiserowitz 2005) to gun possession (Kahan, Slovic, Braman, Gastil & Mertz 2007).

The impact of cultural outlooks on risk perceptions tends to interact with other individual characteristics such as race and gender. White males have been shown to be less concerned with technological and environmental risks than are women and minorities (Flynn, Slovic & Mertz 1994). Research has found that this so-called "white male effect" is driven by a relatively discrete subset of white men who hold distinctively hierarchical and individualistic worldviews (Finucane, Slovic, Mertz, Flynn & Satterfield 2000), outlooks associated in general with skepticism toward environmental risks (Dake 1991). People who hold more egalitarian and communitarian values tend to be uniformly sensitive toward environmental risks irrespective of race and gender (Kahan, Slovic, Braman, Gastil & Mertz 2007).

Although by no means the only psychological dynamic that is likely to shape nanotechnology risk perceptions, cultural cognition could prove an especially consequential one. Knowing little about this novel science, individuals are likely to rely on cultural predispositions toward environmental risks to make sense of what they are learning. Groups with risk-sensitive dispositions and those with risk-skeptical dispositions are thus naturally poised to form opposing views. The gulf between them, moreover, could well grow as individuals confer with culturally like-minded peers, who as a result of the same predispositions are likely to hold opinions that are relatively uniform—and uniformly opposed to those held by persons of competing cultural out-

looks. that are predominantly in line with those same predispositions. If these self-reinforcing dynamics take hold, nanotechnology, like nuclear power and genetically modified foods, could become a focal point for intense, culturally rooted political conflict. Such conflict would be a barrier to considered public deliberation, not to mention a potential threat to the development of nanotechnology.

Two previous experimental studies conducted by the Cultural Cognition Project, in collaboration with the Project on Emerging Nanotechnologies, lend credence to this scenario. The first found that individuals who are relatively unfamiliar with nanotechnology nevertheless form rapid, affective assessments of its risks and benefits and, when exposed to balanced information about it, tend to polarize along cultural lines (Kahan, Slovic, Braman, Gastil, & Cohen 2007). The second found that the reaction of individuals to information about nanotechnology is highly conditional on the relationship between individuals' cultural outlooks and the perceived outlooks of the information source. Accordingly, when individuals observe a policy expert whose values they share advancing the position they are culturally predisposed to accept, and another policy expert whose values they find alien advancing the position they are culturally predisposed to reject, cultural polarization on nanotechnology risks grows even larger (Kahan, Slovic, Braman, Gastil, Cohen & Kysar 2008).

At the same time the CCP/PEN studies suggested the threat that cultural cognition could pose to enlightened deliberation, they also suggested how an understanding of the mechanisms of cultural cognition might be used to counteract that very threat. The relationship between culture and credibility, for example, implies that individuals can be made more receptive to evidence they might be predisposed to reject *when* it is supplied to them by an expert whose values they share. Indeed, in a "pluralistic information environment"—one in which individuals can perceive no pattern between positions on nanotechnology risks and the perceived values of information sources—cultural polarization is significantly reduced (Kahan, Slovic, Braman, Gastil, Cohen & Kysar 2008). Those interested in promoting open-minded public discussion of the best evidence that science reveals, then, should commit themselves to assuring that members of the public are furnished with conspicuous examples of experts of diverse cultural outlooks on *both sides* of any debated issue.

The previous CCP/PEN studies suggested a profitable course of action for public-opinion researchers, too. It is that they continue to focus on identifying how the perception of nanotechnology risk perceptions are likely to be influenced by the mechanisms of cultural cognition, for such study is likely to yield realistic insights into how public deliberation might go wrong *and* into what might be done to prevent that.

The Current Study

The current study examines a mechanism of exactly that character: *information framing*. A "framing effect" occurs when some element of presentation that is logically unrelated to the content of information nevertheless affects the impact of that information on beliefs or behavior. We investigated how framings that either *threaten* or *affirm* a recipient's cultural worldview can influence that individual's assessment of information on nanotechnology risks and benefits.

Identity-Threat and -Affirmation

Individuals conform their factual beliefs to their group commitments as a means of psychic self-defense. We all depend critically on our connection to others for material, emotional, and other forms of support. The prospect of disagreeing with our peers on the risks and benefits of some activity (owning a gun, say) that our group intensely values (or despises) threatens to drive a wedge between us and persons' whose good opinion is essential to our well-being. To resist that threat, we naturally resist information that challenges beliefs that are dominant within our cultural groups (Cohen 2003; Kahan, Braman, Gastil, Slovic & Mertz 2007).

This self-defensive resistance to information can be counteracted, however, by identity *affirmation*. Boosting a person's sense self promotes open-mindedness because it creates a buffer that offsets the threat a person experiences when she contemplates information that challenges beliefs dominant among her peers (Cohen, Aronson & Steele 2000; Cohen, Bastardi, Sherman, Hsu, McGoey & Ross 2007).

These dynamics can affect risk perceptions through framing effects. Individuals are more likely to resist information when it is framed in a way that threatens their cultural commitments, and more likely to give it considered attention when it is framed in a way that affirms their commitments (Kahan, Slovic, Braman & Gastil 2006).

An example involves the impact of identity-affirming and identity-threatening information on perceptions of the risk of global warming. Persons who hold individualistic worldviews tend to be skeptical about global warming because they perceive (subconsciously) that broad acceptance of climate change as a serious environmental risk could lead to restrictions on commerce and industry, activities that they culturally value. Individualists also tend to have a positive view toward nuclear power, a form of technology that symbolizes human initiative and mastery over nature and that has the potential to enable commerce and industry into the indefinite future. In an experiment, individualists who were told nuclear power, a practice that *affirms* their worldview, furnishes a potential solution to global warming were significantly more likely to credit scientific information about the existence, causes, and consequences of climate change than were individualists who were told that the solution to global warming is more restrictive anti-pollution regulations, a policy that *threatens* their worldview. Indeed, because they were threatened, the individualists who were told that anti-pollution regulations would be necessary were *less* likely to believe that global warming is occurring, is caused by humans, and is dangerous for the environment than were individualists who had not been exposed to scientific information asserting these facts (Cultural Cognition Project 2007).

Study Design and Hypotheses

We conducted a study of the nanotechnology risk-benefit perceptions of a diverse sample of 1,600 Americans.[1] The subjects worldviews had been previously measured using scales developed for the study of the cultural cognition of risk (Kahan, Slovic, Braman, Gastil & Mertz

[1] Subjects were drawn from an on-line panel recruited by Polimetrix for public opinion research and participated in the study through Polimetrix's on-line testing facilities. For more information on the sample and on Polimetrix's sampling methods, see the Appendix A.

2007; Kahan & Braman 2008; Kahan, Hoffman & Braman, in press). Subjects reported their level of agreement or disagreement with three statements:

> NANOBENEFIT. The benefits of nanotechnology are likely to be large.
>
> NANORISK. The risks of nanotechnology are likely to be large.
>
> NANOBALANCE. On the whole, the benefits of nanotechnology will outweigh the risks.

Responses to these items were combined into a single scale, NRISK (α = .62), that measured subjects' perception of risks relative to benefits.[2]

Before their perceptions were elicited, the subjects—85% of whom reported knowing "little" or "nothing at all" about nanotechnology before the study—were first assigned to read one of four versions of a fictitious newspaper story that described a report in which scientists called for more research on the risks and benefits of nanotechnology (Figure 1). Each version contained a conspicuous, shaded inset, which set forth a brief definition of nanotechnology and two paragraphs of balanced information on its potential risks and benefits;[3] this material, presented without any additional framing, had been shown in the first CCP/PEN study to generate cultural polarization (Kahan, Slovic, Braman, Gastil, & Cohen 2007).

The four articles differed in their headlines and in their first and last paragraphs, which were worded to emphasize different applications of nanotechnology. The shaded inset common to all articles described a general range of potential benefits and risks, and the response measures solicited perceptions of benefits and risks generally. We nevertheless hypothesized that the different applications made salient by the various articles would be alternately identity-threatening and –affirming to members of different cultural groups, and thus affect their perception of risks and benefits across conditions.

The article read by subjects in the "Consumer Condition" highlighted the use of nanotechnology in commercially produced consumer goods. We hypothesized that this application of nanotechnology would be identity-threatening to subjects who hold relatively egalitarian and communitarian worldviews because these persons tend to associate commerce and industry with individual selfishness and unjust distributions of wealth. By the same token, we expected subjects holding hierarchical and individualistic worldviews—particularly white males with such outlooks—to be identity-affirmed; these types of persons tend to associate commerce and industry with individual freedom and the competence of social elites. Accordingly, we predicted that in the Consumer Condition, white male hierarchical individualists would see more benefit and less risk in nanotechnology than others, particularly egalitarian communitarians.

---

[2] NANOBENEFIT and NANOBALANCE were thus reverse coded.

[3] The order of the benefit and risk paragraphs were rotated across subjects.

Figure 1. Framing Materials

The article read by subjects in the "Regulation Condition" emphasized the potential of nanotechnology to "make government regulation of pollution emissions more effective" by "enhanc[ing] the cost-effectiveness of government monitoring of industrial pollution emissions." Recognizing that "industrial pollution" is a problem implies that commerce and industry are harmful and worthy of restriction. Accordingly, we anticipated that highlighting the application of nanotechnology to promote government anti-pollution regulation would be identity-threatening to hierarchical individualists, particularly white male ones, and identity-affirming to egalitarian communitarians. We therefore hypothesized that in the Regulation Condition there would be a reversal of the pattern of risk-benefit perceptions we expected to see in the Consumer Condition.

The article read by subjects in the "Green-to-Gold Condition" described how "commercially developed" nanotechnology devices would create "new market opportunities for firms specializing in cleaning the environment." By identifying how environmental protection can itself be a form of commerce, this application, we surmised, would be simultaneously identity-affirming for both egalitarian communitarians and white male hierarchical individualists. We thus expected subjects of both types to form more positive views of the risks and benefits of nanotechnology than their counterparts in their respective identity-threatening conditions (the

Consumer Condition for the egalitarian communitarians, the Regulation Condition for white male hierarchical individualists).

The inspiration for the Green-to-Gold Condition was a new theme in environmentalist advocacy (Esty & Winston 2007). Itself a self-conscious exercise in framing, the "green to gold" argument seeks to extend the appeal of environmentalism by effacing its anti-market connotations (Nordhaus & Shellenberger 2007; Kysar 2008). Exponents of "green to gold" explicitly tout nanotechnology as one of the fonts of commercial enrichment likely to be stimulated by a mandate to make commerce cleaner and less destructive of nonrenewable resources (Esty & Winston 2007, p. 17). We decided to test whether this manner of characterizing nanotechnology would likewise help to free nanotechnology of associations that make egalitarians and communitarians instinctively fear the risk that a new commercial technology poses to the environment.

Finally, subjects in the "National Security Condition" read an article that emphasized the use of nanotechnology to thwart the use of biological or chemical weapons by terrorists or enemy military forces. We expected this condition would drive a wedge between hierarchs and individualists: the former, we surmised, would be identity-affirmed by the invocation of dangers that underscore the need to defer to authority, while the latter would be identity-threatened by the specter of contingencies that have historically have been used to justify governmental abridgements of liberty. We thus hypothesized that this Condition would feature cultural alignments visibly different from those in the other experimental conditions.

Results

Results of the experiment are reported in Table 1 and Figure 2 and

Figure 3. They revealed significant framing effects both across and within conditions.

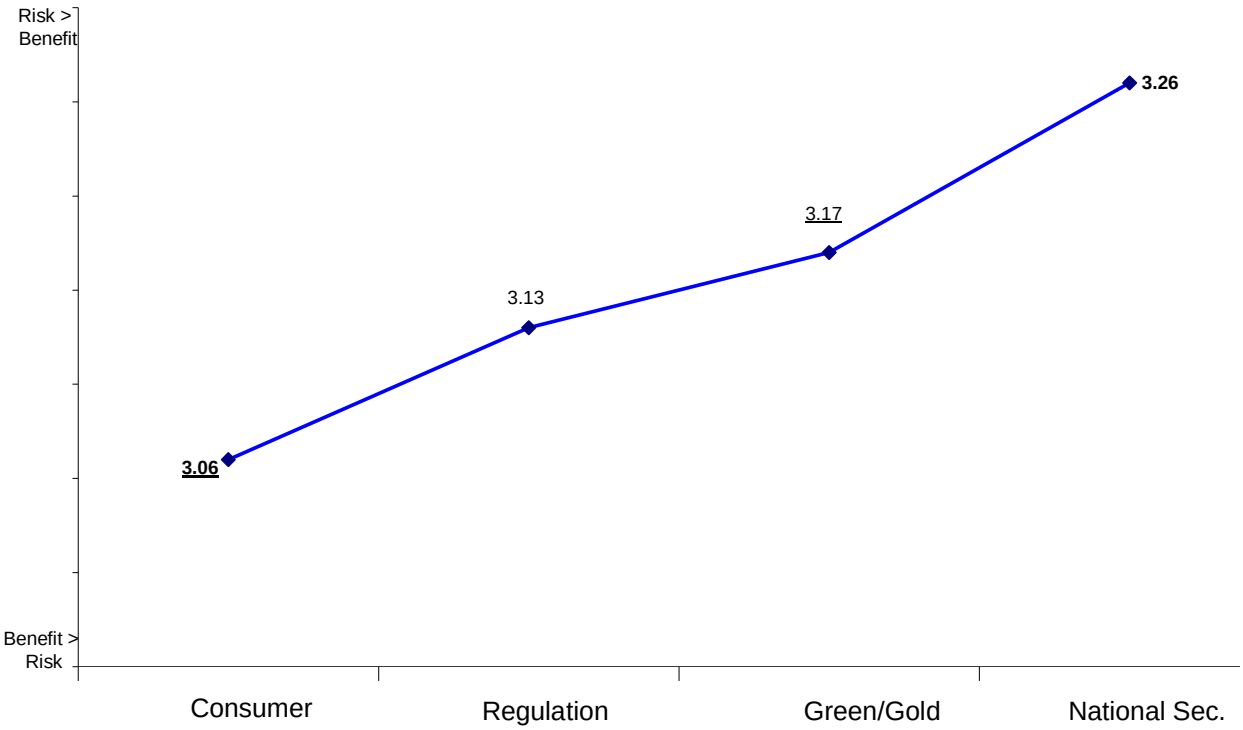
	Consumer		*Regulation*		*Green-to-Gold*		*National Security*	
	n	Mean	*n*	Mean	*n*	Mean	*n*	Mean
Overall	404	**3.06**	377	3.13	406	3.17	413	**3.26**
Male	182	**2.82**	183	3.09	190	**3.00**	184	**3.12**
Female	222	**3.26**	194	3.17	216	**3.32**	229	**3.38**
White	68	3.03	397	3.15	310	**3.12**	326	3.22
Nonwhite	336	3.18	70	3.07	96	**3.32**	87	3.40
Hierarchical Individualist	148	3.00	137	**3.23**	153	3.16	145	3.16
Egalitarian Communitarian	153	3.03	146	**3.01**	144	3.14	157	3.36
White HI Male	79	**2.74**	76	3.18	99	**2.89**	76	**2.99**
Everyone Else	325	**3.14**	301	3.12	318	**3.25**	337	**3.32**

Mean scores on 6-pt NRISK scale. In case of paired groups, **bold** denotes difference between means of groups *within* condition significant at $p \leq .05$, underscored significant at $p \leq .10$. In case of "overall," **bold** denotes difference between means *across* conditions significant at $p \leq .05$, underscored significant at $p \leq .10$

Table 1. Experiment Results

Across-conditions effects—differences in the mean NRISK scores in the various conditions—reflects the impact that making one or another nanotechnology salient had on risk-benefit perceptions generally. Consumer Condition had the lowest NRISK score, and the National Security Condition, the highest. That is, study subjects on the whole tended to see nanotechnology as

posing more risk relative to its benefits generally when its use for detecting chemical and biological weapons use was emphasized than when its use for consumer goods was emphasized. Surprisingly, the NRISK score of Green Gold was higher than Consumer, although the significance of the difference was marginal (p = .08).

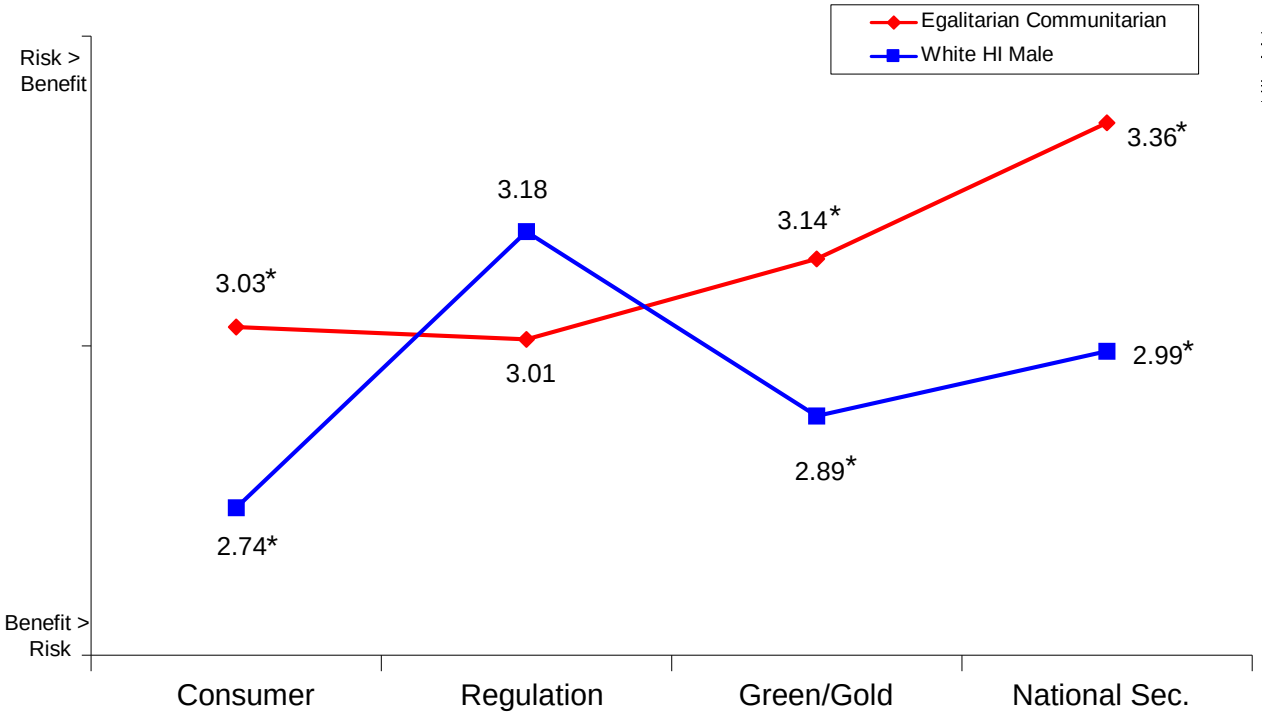


6-pt Nrisk scale. **Bold** denotes group means significantly different at $p \leq .05$, underscore at $p \leq .10$.

Figure 2. Across-Condition Effects

Within-condition effects—differences in the mean NRISK scores of different groups within particular conditions—reflect how framing affected the perceptions of individuals of varying characteristics. The effects in the Consumer and Regulation Conditions conformed to our hypotheses. Egalitarian Communitarians had a significantly higher NRISK score than did white male Hierarchical Individualists in the Consumer Condition (Figure 3). This was consistent with our expectation that the former would be identity threatened and the latter identity affirmed by the salience of commercial uses of nanotechnology. In contrast, we predicted that white male hierarchical individualists would be identity threatened, and egalitarian communitarians identity affirmed, in the Regulation Condition. Consistent with that hypothesis, in that condition, it was the white male hierarchical individualists who had the higher NRISK score.[4]

[4] The difference between the NRISK score of white male hierarchical individualists and that of egalitarian communitarians in the Regulation Condition was not statistically significant, but the change in the *size* of the discrepancy of the scores of those two groups in the Regulation Condition relative to that in Consumer Condition was statistically significant. The significant *effect* of the Regulation Condition framing, in other words, eliminated the difference that existed between the groups in the Consumer Condition.



6-pt NRISK scale.* denotes group means significantly different at $p \leq .05$

Figure 3. Within-Condition Effects

The results in the Green-to-Gold Condition, however, were inconsistent with our hypothesis. We expected that both egalitarian communitarians and white male hierarchical individualists would be affirmed in this condition and that as a result they would exhibit lower NRISK scores than their counterparts in the conditions in which these groups were identity threatened (Consumer and Regulation, respectively). Instead, the NRISK scores of both groups were *higher* in Green-to-Gold than they were in their respective identity-threatened conditions. Relative to their counterparts in the Regulation Condition, egalitarian communitarians in Green-to-Gold perceived more risks relative to benefits, while white male hierarchical individualists perceived less. The result was a degree of cultural polarization akin to that in the Consumer Condition.

The result in the National Security Condition also failed to conform to our hypothesis. The expected gap between hierarchs and individualists did not emerge. Instead, we observed persistence of the pattern of cultural polarization observed in the Consumer and Green-to-Gold Conditions (egalitarian communitarian perceiving greater risk relative to benefit than did white male hierarchical individualists). The NRISK score of white male hierarchical individualists was lower, however, than in the Regulation Condition, indicating that the magnitude of the increased concern on the part of egalitarian communitarians explained why National Security had the highest NRISK score across conditions.

Discussion

We designed information framings that we anticipated would alternately threaten and affirm individuals of diverse cultural identities, and thus alternately aggravate and mitigate closed-mindedness characteristic of cultural cognition. We observed results suggestive of the hypothesized effects in the Consumer and Regulation Conditions. But we did not see the distinctive pattern of identity threat and affirmation anticipated in the National Security Condition and (even more disappointingly) the anticipated simultaneous pattern of identity affirmation anticipated in the Green-to-Gold Condition. Those conditions, moreover, also generated perceptions of risk nanotechnology that were unexpectedly high in relation to the Consumer Condition.

It is, of course, not perfectly clear how to explain the results that diverged from our hypotheses. In the case of Green-to-Gold, one possibility might be that for nanotechnology it simply is not the case that fusing pro-market and pro-environment themes has the power to be identity-affirming simultaneously for cultural groups that ordinarily disagree about environmental risks. Alternatively, the anticipated effect might have been impeded by some particular feature of our Green-to-Gold stimulus.

The *across-condition* effects observed in the experiment, while unanticipated, are nevertheless highly suggestive. The Green-to-Gold and National Security versions of the newspaper article did not make salient any risk from nanotechnology that was not made equally prominent in the other versions of the article. Indeed, relative to the version in the Consumer Condition, which emphasized the use of nanotechnology for production of consumer goods, these two versions of the article made the potential of nanotechnology to *mitigate* societal risks more conspicuous. Why then did subjects in the Green-to-Gold and National Security Conditions perceive the risks of nanotechnology to be higher relative to its benefits than did those in the Consumer Condition?

The answer, we surmise, has to do with the fear provoked by the *non*-nanotechnology risks that were featured in the Green-to-Gold and National Security Conditions. More *vivid* depictions of risk inflate estimations of the likelihood of such dangers because they arouse greater affective responses (Slovic, Finucane, Peters & MacGregor 2004; Loewenstein, Weber, Hsee & Welch 2001). The risks described in Green-to-Gold and National Security—"arsenic [in] groundwater"; "biological and chemical attacks"—were characterized to in much more vivid, and hence much more alarming, terms than any described in the Consumer Condition. One plausible conjecture, then, is that these risks created a greater state of anxiety, which then spilled over to subjects' assessments of the risks associated with nanotechnology. In other words, framing nanotechnology as risk abating could have the paradoxical effect of causing individuals to see the risks of nanotechnology itself as outweighing its benefits.

Conclusion: The Risks and Benefits of Nanotechnology Risk-Benefit Framing

Our results show that framing matters—in ways that we anticipated and in some important ones that we did not. What is the practical upshot of these findings?

To answer that question, one has to know why exactly one is asking it. If one knew *what* members of the public should think about nanotechnology—that it poses immense potential dangers and should be subject to significant restrictions; that it poses little if any risk and should be

shielded from regulatory interference—then one could arguably use data of the sort we have presented to help identify information framings crafted to induce the public (including specifically identifiable groups within it) to form the appropriate attitude.

But we don't have a position on precisely what the public should believe about the risks of nanotechnology. We don't believe anyone—or at least anyone who honestly wants the public to get it *right*—could have a strong view on that issue at this point, because the scientific research necessary to determine the risks nanotechnology involves, if any, remains to be conducted.

The aim of our research is to contribute to the public's receptivity to whatever information such research ultimately reveals. There are many reasons not to take such receptivity for granted (Scheufele 2006). Principal among them is the demonstrated tendency of persons to attend selectively to information about risk in a way that fits their cultural predispositions toward environmental and technological risks. The series of studies conducted by CCP and PEN have been dedicated to identifying how cultural cognition might interfere with the dissemination of sound scientific information about nanotechnology, and what those who favor enlightened public deliberations about this important new science might do to counteract such inference.

From this perspective, we believe the current study teaches a number of practical lessons. Individuals react in a defensive, closed-minded fashion to information that they believe threatens their core values. Accordingly, information communicators should be sensitive to the emotional and symbolic associations that different applications of nanotechnology can trigger in the minds of culturally diverse members of the public. Emphasizing nanotechnology consumer goods, for example, suggests a link between it and competitive market behavior, and thus reinforce the disposition of persons with egalitarian and communitarian outlooks to credit information that nanotechnology is dangerous. In contrast, individuals who are hierarchical and individualistic will downplay nanotechnology's benefits and attend more to its risks if they consider information after being made aware of the contribution nanotechnology can make to anti-pollution regulation.

Individuals consider information more carefully and open-mindedly when they feel affirmed rather than threatened. Ideally, then, sound information about nanotechnology should be framed in a way that simultaneously affirms the values of diverse members of the public.

In our own study, however, we failed to identify a framing that achieves this result. Emphasizing how nanotechnology could create market opportunities for firms that specialize in cleaning the environment seemed, if anything, to be simultaneously *threatening* to egalitarian individualists and hierarchical individualists. At least as we structured it, "green to gold" was no silver bullet.

Indeed, still another practical lesson of our study involves the potential hazards of information framings that emphasize the potential of nanotechnology to mitigate societal risks generally. When exposed to information that made salient the power of nanotechnology to remove arsenic from groundwater, or to detect biological and chemical weapons, individuals concluded that nanotechnology *itself* was more risky than did individuals exposed to information that made the use of nanotechnology for consumer goods salient. In the former two cases, the anxiety aroused by especially vivid risks unrelated to nanotechnology infected the processing of informa-

tion on the risks and benefits of nanotechnology generally, and dominated any identity-affirmation effects.

These findings, of course, underscore the importance of additional nanotechnology-risk communication research. Not only is additional study needed to devise universally affirming message framings and to identify techniques for avoiding the anxiety associated with information on risk mitigation. Research should also be conducted to determine how message framings interact with the credibility of culturally identifiable advocates, a dynamic that a previous CCP/PEN study showed to be especially important (Kahan, Slovic, Braman, Gastil, Cohen & Kysar 2008).

We acknowledge, in sum, that much work remains to be done before risk communicators can effectively manage the framing of nanotechnology risks. But we believe the study of nanotechnology risk perceptions has already advanced beyond the point where anyone can seriously question the utility of learning how to do so.

References

Cohen, G. L. (2003). Party over Policy: The Dominating Impact of Group Influence on Political Beliefs. Journal of Personality & Social Psychology, 85(5), 808-822.

Cohen, G. L., Aronson, J., & Steele, C. M. (2000). When Beliefs Yield to Evidence: Reducing Biased Evaluation by Affirming the Self. *Personality and Social Psychology Bulletin, 26*(9), 1151-1164.

Cohen, G. L., Bastardi, A., Sherman, D. K., Hsu, L., McGoey, M., & Ross, L. (2007). Bridging the partisan divide: Self-affirmation reduces ideological closed-mindedness and inflexibility in negotiation. *Journal of Personality and Social Psychology, 93*(3), 415-430.

Cultural Cognition Project (2007). The Second National Risk and Culture Study: Making Sense of—and Making Progress in—the American Culture War of Fact, http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1017189.

Dake, K. (1991). Orienting Dispositions in the Perception of Risk: An Analysis of Contemporary Worldviews and Cultural Biases. *J. Cross-Cultural Psych., 22*, 61.

DiMaggio, P. (1997). Culture and Cognition. Annual Review of Sociology, 23, 263-287.

Douglas, M. (1966). *Purity and danger: an analysis of concepts of pollution and taboo*. New York,: Praeger.

Esty, D. C., & Winston, A. S. (2006). *Green to gold : how smart companies use environmental strategy to innovate, create value, and build competitive advantage*. New Haven, [Conn.]: Yale University Press.

Finucane, M., Slovic, P., Mertz, C. K., Flynn, J., & Satterfield, T. A. (2000). Gender, Race, and Perceived Risk: The "White Male" Effect. *Health, Risk, & Soc'y, 3*(2), 159-172.

Flynn, J., Slovic, P., & Mertz, C. K. (1994). Gender, Race, and Perception of Environmental Health Risk. *Risk Analysis, 14*(6), 1101-1108.

Gutierrez, R., & Giner-Sorolla, R. (2007). Anger, disgust, and presumption of harm as reactions to taboo-breaking Behaviors. *Emotion, 7*(4), 853-868.

Jenkins-Smith, H. (2001). Modeling Stigma: An Empirical Analysis of Nuclear Waste Images of Nevada. In J. Flynn, P. Slovic & H. Kunreuther (Eds.), *Risk, media, and stigma : understanding public challenges to modern science and technology* (pp. 107-132). London ; Sterling, VA: Earthscan.

Kahan, D. M., & Braman, D. (2008). The Self-defensive Cognition of Self-defense. *American Criminal Law Review, 45*(1), 1-65.

Kahan, D. M., Braman, D., Gastil, J., Slovic, P., & Mertz, C. K. (2007). Culture and Identity-Protective Cognition: Explaining the White-Male Effect in Risk Perception. Journal of Empirical Legal Studies, 4(3), 465-505.

Kahan, D. M., Hoffman, D. A., & Braman, D., In Press. Whose Eyes are You Going to Believe? Scott v. Harris and the Perils of Cognitive Illiberalism. *Harv. L. Rev., 122*.

Kahan, D. M., Slovic, P., Braman, D., & Gastil, J. (2006). Fear of Democracy: A Cultural Critique of Sunstein on Risk. Harvard Law Review, 119, 1071-1109.

Kahan, D. M., Slovic, P., Braman, D., Gastil, J., & Cohen, G. L. (2007). Affect, Values, and Nanotechnology Risk Perceptions: An Experimental Investigation. Cultural Cognition Working Paper No. 22.

Kahan, D. M., Slovic, P., Braman, D., Gastil, J., Cohen, G. L., & Kysar, D. A. (2008). *Biased Assimilation, Polarization, and Cultural Credibility: An Experimental Study of Nanotechnology Risk Perception*, Woodrow Wilson Center, Project on Emerging Nanotechnologies.

Kysar, D. A. (2008). The Consultant's Republic. *Harvard Law Review, 121*, 2041-2084.

Leiserowitz, A. A. (2005). American risk perceptions: Is climate change dangerous? *Risk Analysis, 25*(6), 1433-1442.

Loewenstein, G. F., Weber, E. U., Hsee, C. K., & Welch, N. (2001). Risk as Feelings. *Psychological Bulletin, 127*(2), 267-287.

Nordhaus, T., & Shellenberger, M. (2007). *Break through : from the death of environmentalism to the politics of possibility*. Boston: Houghton Mifflin.

Peters, E., & Slovic, P. (1996). The Role of Affect and Worldviews as Orienting Dispositions in the Perception and Acceptance of Nuclear Power. *Journal of Applied Social Psychology, 26*(16), 1427-1453.

Scheufele, D. A. (2006). Five lessons in nano outreach. *Materials Today, 9*(5), 64-64.

Slovic, P., Finucane, M. L., Peters, E., & MacGregor, D. G. (2004). Risk as Analysis and Risk as Feelings: Some Thoughts About Affect, Reason, Risk, and Rationality. *Risk Analysis, 24*(2), 311-322.

Appendix A. Information on On-Line Sample

1. *Polimetrix*

Polimetrix (http://www.polimetrix.com/) is a public opinion research firm that conducts on-line surveys and experiments on behalf of academic and governmental researchers and commercial customers (including political campaigns). It maintains a panel of over 1 million Americans that is uses to construct representative study samples through a population-matching algorithm. For more information, see http://www.polimetrix.com/documents/YGPolimetrixSampleMatching.pdf.

2. *Demographic composition of sample for this study*

a. Total number of subjects: 1,600.

b. Gender: 53.8% female, 46.2% male.

c. Race: 79.9% white, 8.4% African-American.

d. Average age: 49 years.

e. Median household income: $40,000 to $49,000.

f. Median education level: Some college.

3. *Period for Study*

April 27-30, 2008

Appendix B. About the Authors

Dan M. Kahan is the Elizabeth K. Dollard Professor of Law at Yale Law School. His principle areas of research include the legal and policy significance of emotions, social norms, and public risk perceptions. He has published widely in academic journals including the *Harvard Law Review*, the *Columbia Law Review*, and the *University of Chicago Law Review*, and is co-author of *Urgent Times: Policing and Rights in Inner-city Communities* (Beacon Press 1999) (with Tracey Meares). He received his J.D. from Harvard Law School in 1989.

Douglas Kysar, Professor of Law at Yale Law School, is Societal and Ethical Issues Coordinator, National Nanotechnology Infrastructure Network, an integrated networked partnership of user facilities, supported by the National Science Foundation. His works have appeared in the *Harvard Law Review,* the *Columbia Law Review,* the *New York University Law Review,* the *Northwestern University Law Review,* the Cornell Law Review, the *Texas Law Review,* the *Minnesota Law Review, Ecology Law Quarterly,* and the *Boston College Law Review.* Two of Professor Kysar's articles have been selected for presentation in the environmental law category at the Stanford-Yale Junior Faculty Forum. He has been a visiting associate professor at Harvard Law School, a visiting professor at Yale Law School, and a visiting scholar at the Universitat Pompeu Fabra in Barcelona, Spain.

Donald Braman is an Associate Professor of Law at George Washington University. His principle areas of research include the familial and community effects of criminal sanctions, public attitudes towards punishments, and the influence of cultural values on risk perception and legal debates. He has published widely in academic journals and is co-author of *Doing Time on the Outside: Incarceration and Family Life in Urban America* (U. Mich. Press 2004). He received his J.D. from Yale Law School in 2005.

Paul Slovic, Professor of Psychology at the University of Oregon and founder and President of Decision Research, studies human judgment, decision making, and risk analysis. He and his colleagues worldwide have developed methods to describe risk perceptions and measure their impacts on individuals, industry, and society. He publishes extensively and serves as a consultant to industry and government. Dr. Slovic is a past President of the Society for Risk Analysis and in 1991 received its Distinguished Contribution Award. In 1993 he received the Distinguished Scientific Contribution Award from the American Psychological Association. In 1995 he received the Outstanding Contribution to Science Award from the Oregon Academy of Science. He has received honorary doctorates from the Stockholm School of Economics (1996) and the University of East Anglia (2005).

Geoffrey Cohen is an Associate Professor at the University of Colorado at Boulder. Much of his research concerns the processes of self-evaluation and identity maintenance. One area of research addresses the effects on achievement motivation of individuals' group memberships, with a focus on the role of social stereotypes in shaping intellectual identity and performance. A second research area links resistance to probative information, and intransigence in negotiation and social conflict, to concerns of identity maintenance. His laboratory examines the psychological processes underlying significant social problems and phenomena and seeks to use the acquired knowledge of basic processes to develop, refine, and test intervention strategies. Professor Cohen received his Ph.D. from Stanford University in 1998.

John Gastil, Associate Professor, has taught at the University of Washington since 1998. Gastil teaches courses on small group decision making, political deliberation, and public scholarship. From 1994-1997, Gastil conducted public opinion research at the University of New Mexico Institute for Public Policy. He received his Ph.D. in communication from the University of Wisconsin-Madison in 1994, and he received a B.A. in political science from Swarthmore College in 1989. He is the author of *Political Communication and Deliberation*, *The Deliberative Democracy Handbook* (co-edited with Peter Levine), *By Popular Demand* and *Democracy in Small Groups*.