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## ***Framing Effects on Public Opinion about Nanotechnology***

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*In this study, I examine whether Americans' emotions and opinions about nanotechnology are influenced by how the issue is framed. Using data collected from an experiment embedded within a national survey, I find consistent framing effects even though the magnitudes of respondents' opinion changes are not especially large. Frames about specific risks and benefits of nanotechnology are more influential than frames based on general beliefs about the merits of science, and framing nanotechnology as beneficial is only somewhat less powerful than framing it as risky. I conclude by discussing the implications of these framing effects for future mass opinions about nanotechnology.*

**Keywords:** *nanotechnology, framing, public opinion*

*Despite Americans' initially positive reaction to nanotechnology (Cobb and Macoubrie 2004), future public opinion might shift significantly because Americans do not know much about nanotechnology, and because experts disagree about the seriousness of the risks that nanotechnology poses to the public (for assessments of the toxicity of nanoparticles, see Monteiro-Riviere et al. 2005; Oberdorster 2004). "Nanotechnology" is an umbrella term for describing research and technology development that allows for the*

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manipulation and control of materials at the atomic or molecular levels in order to build novel structures and devices. Past experiences with new and complex technologies suggests that attempts to frame nanotechnology might have important consequences for public perceptions about it.

Framing an issue differently often, though not always, affects opinions, and this research explores potential framing effects on the important issue of nanotechnology. In particular, I investigate the outcome of framing nanotechnology according to its potential risks versus its benefits, and whether frames using fundamental philosophical positions about the merits of science can affect opinions. Basic beliefs about the role of science—that it inevitably leads to progress or that it often fails to solve major problems—might shape opinions about nanotechnology. Using philosophical values of science frames in addition to specific risks and benefits frames allows for the study of whether values alone can be used to frame scientific issues.

Why study the framing of nanotechnology if mass preferences are not thought to dictate scientific policy choices? One reason is that policy makers are thought to be responsive to the general policy direction favored by mass opinion (Page and Shapiro 1992). Elites might not implement specific policy because of public opinion, but they are more likely to fund some scientific projects, and not others, when public preferences support the policy decision. Or, public opinion sometimes has a direct impact, such as when voters in the state of California recently approved a bond initiative to fund stem cell research for the next decade (Holden 2004).

A second reason is that opinions about nanotechnology could be radically altered by exposure to dramatic events and new information because Americans' opinions about nanotechnology are based on a minimal amount of factual knowledge (Cobb and Macoubrie 2004). Media framing of genetically modified foods (GMF) as embroiled in scientific controversy, for example, was linked to Europeans' increasingly negative opinions (Gaskell et al. 1999). Likewise, exposure to new and critical information might also underlie Americans' significant and steady decline in support for GMF (Priest 2000). A framing experiment that presents both positive and negative information about nanotechnology can help shed some light about the possible directions future opinions might take (Toumey 2004).

### *Nanotechnology and Public Opinion*

Some scientists and policy makers boldly predict that nanotechnology will become the catalyst of our next industrial revolution (National Science and Technology Council 2000). The annual global impact of nanotechnology-

based products, for example, is expected to approach \$1 trillion around the end of this decade (Roco and Bainbridge 2001). Nanotechnology has the potential to dramatically affect not only the economy, but also social, legal, and ethical domains (Lewenstein 2004). Thus, public perceptions about nanotechnology will arguably have significant social and financial consequences (Roco 2003).

### *Public Perceptions about Nanotechnology*

While government, industry, and scientists are investing millions of dollars to better understand what the public thinks about nanotechnology, early studies demonstrate that the mass public is not yet well informed about it (Cobb and Macoubrie 2004; Macoubrie forthcoming). Most Americans readily admit that they have heard little or nothing about it, and when quizzed about how it works, they do poorly at answering basic factual questions (Cobb and Macoubrie 2004). Nevertheless, their first impressions of it are guardedly optimistic (see also Bainbridge 2002). Although the mass public does not predict nanotechnology will be devoid of risks, a solid majority of survey respondents in the Cobb and Macoubrie (2004) study thought that benefits will be equal to or greater than these risks. Likewise, Americans reported having positive emotional reactions to nanotechnology, such as feeling significantly more hopeful about it than worried or angry about it. While 83 percent of respondents reported feeling hopeful, for example, only 26 percent and 18 percent, respectively, claimed to feel worried or angry about it (Cobb and Macoubrie 2004).

If most Americans admit to not knowing much about nanotechnology, and yet they are forming opinions about it, this suggests that perceptions about its risks and benefits are based on external cues, such as trust in regulators or opinions about the general merits of science. In addition, because Americans lack specific information about nanotechnology, their opinions about it should be also sensitive to new information. According to a vast amount of literature on what influences public opinion, one of the most important qualities about how a new issue is perceived is how it is initially framed. In turn, how an issue is initially framed is often crucial to determining winners and losers in policy debates.

### *Framing Effects and Their Causes*

Framing is ordinarily examined in the context of elites' attempts to influence public opinion about certain issues (Greene 2004). Frames are thought

to hold particular sway with the mass public because frames reduce confusing issues that are remote from most people's direct experiences into manageable packages of understandable information (Popkin 1994). Scholars observe that attempts to frame are ubiquitous in politics because almost every issue has alternative interpretations, but they also find that *framing effects* are less powerful than previously thought.

### *Issue Framing*

To be clear, there are at least two types of framing effects that are actually disparate phenomenon but are (improperly) identically labeled. In this study, I am referring to *issue framing* effects commonly studied in the political communication literature rather than *equivalency framing* (Druckman 2004).<sup>1</sup> Issue framing is when “qualitatively different yet potentially relevant considerations” (Druckman 2004, 672) are used to describe the same issue. Similarly, Entman (1993) writes that issue framing is the process of selecting and highlighting some facets of events or issues over their alternatives and making connections among them with the objective of promoting a particular interpretation or evaluation and a preferred solution. Abortion, for example, is typically framed by one side of the debate as “the right to choose” and by the other side as “abortion is murder.”

### *How Framing Works*

Two different cognitive processes, accessibility and salience, are thought to explain how framing effects work. Accessibility refers to the availability of information used to form opinions. Information that is accessible in memory is often used in place of more reliable diagnostic information because people are limited in cognitive ability (Fiske and Taylor 1991) and ordinarily are not motivated to search for more relevant information (Petty and Cacioppo 1986). The expression of opinions is, therefore, easily manipulated by frames because they provide the most recent or memorable information (Zaller and Feldman 1992). Alternatively, the salience hypothesis, sometimes called the “thoughtful receiver hypothesis” (Brewer 2001), holds that individuals consciously increase the importance they attach to specific considerations (Nelson, Oxley, and Clawson 1997). This explains why some of the most successful frames invoke core values: because a recipient of these frames already endorses the values in them. When exposed to a frame that says campaign spending is “free speech,” for example, people deliberately

weight the value of free speech more heavily than they would otherwise when forming opinions about campaign finance reform.

### *Expectations*

The framing literature offers multiple theoretical reasons to expect modest effects in this study. On some issues, for example, framing effects are often weak to nonexistent (Druckman 2001b), and on other issues framing effects are entirely contingent upon a receiver's prior beliefs (Haider-Markel and Joslyn 2001). In addition, some kinds of frames are simply ineffective (Chong 2000). The literature also suggests that frames about the risks of nanotechnology will be more powerful than those about its benefit frames because negative information is generally thought to be more influential than positive information (Cobb and Kuklinski 1997; Lau 1985).

### *Cause of Framing*

The first reason to suspect framing effects on nanotechnology will be limited is that the literature lands squarely behind the "thoughtful receiver" hypothesis (Nelson and Oxley 1999; Nelson, Oxley, and Clawson 1997). In framing studies about political issues, greater general political knowledge is found to facilitate framing (Druckman and Nelson 2003; Miller and Krosnick 2000), but most Americans are not knowledgeable about science in general (National Science Board 2002). The lack of knowledge means that most respondents in a survey about nanotechnology will be unable to connect the frames to their opinions about the issue, especially when exposed to value frames. While frames that more strongly resonate with existing cultural norms ordinarily are more powerful than those that do not (Gamson 1992), science values frames are probably going to be more confusing than consequential.

### *Use of a Control Group*

A second reason for expecting constrained effects is that I utilize a control group in this study. Many, if not most, framing studies simply compare opinions across two or more framing conditions, which might obscure the fact that one frame did not significantly affect opinions even though the differences in opinions between two or more framing conditions are statistically

significant. While the strategy of discarding a control group is arguably appropriate for certain kinds of analyses, such as studying how certain variables mediate the effects of one kind of frame versus another (i.e., how “need for cognition” moderates reactions to a loss-versus-a-gain frame; Steward et al. 2003), it is less than ideal for ascertaining the true magnitude of different frames on an issue. Thus, I compare opinions in each of the framing conditions to those in the control group, and, consequently, I expect to find less significant issue framing than is often reported.

### *One-sided versus Two-sided Frames*

Extant research typically examines framing effects without considering what happens when opposing frames are encountered simultaneously. This is a surprising oversight, and studies that actually expose respondents to frames on both sides of an issue find framing effects found in one-sided framing conditions often disappear (Druckman 2004). Thus, I anticipate greater framing effects when respondents hear a one-sided frame and for these effects to fade away when opposing frames are heard together.

### *Hard Issues*

On the other hand, there is at least one reason to anticipate sizeable framing effects on this issue. According to Carmines and Stimson (1980), a “hard” issue is new, complicated, and unfamiliar to most people. Nanotechnology is obviously a hard issue. The relevance of this fact for predicting framing effects is identified by Joslyn and Haider-Markel (2002), who write that framing effects should be greater on these kinds of issues because individuals will have weaker predispositions based on technical knowledge rather than emotions. Opinions that are less strongly held, in other words, should be more susceptible to framing effects.

### *Risks versus Benefits*

A final prediction derived from the literature is that frames emphasizing risks should be more powerful than ones emphasizing benefits. In the field of risk perception, for example, negative messages are found to be more powerful partly because they are more trusted than positive messages (Slovic 1993). Likewise, studies of politics and persuasion and decision making also find a negativity bias (Cobb and Kuklinski 1997; Kahneman and Tversky 1979). While there are some unresolved questions as to the precise reasons for a negativity bias (White et al. 2003), the weight of the evidence strongly

suggests that frames about the risks of nanotechnology will be more important for shaping opinions.

### *Data and Methods*

To examine potential framing effects on opinions about nanotechnology, I conducted an experiment embedded within a nationally representative phone survey. This survey of public attitudes about nanotechnology was a random-digit-dialed survey of adults eighteen years or older in the continental United States between late March and early April of 2004 ( $N = 1,536$ ).<sup>2</sup> Respondents were randomly assigned to one of ten experimental conditions: an oversampled control group ( $N = 330$ ) or one of nine unique framing conditions about the risks or benefits of nanotechnology ( $N = 134$ , each). Respondents in all conditions, even the control group, heard a brief, objective description about nanotechnology. Next, respondents in each of the nine framing conditions heard a distinct way of framing nanotechnology. In six of the experimental conditions, respondents listened to one-sided frames. Three of the one-sided frames were “pro” and three were “anti” nanotechnology. The remaining three conditions are two-sided frames that pit each of the preceding “pro” frames against their equivalent antinotechnology frames. Substantive questions about nanotechnology were then asked immediately following the frames.

### *The Frames*

The baseline frames used in this study represent two opposing philosophical values about the role of science. I label the first kind “conservative humanism,” and the other “cornucopian.” A conservative humanistic frame is skeptical that science can solve deficiencies in the human condition. Although humanism has been associated with a preference for the secular over religious, conservative humanists would still posit that science is not a “silver bullet” for our problems. Conversely, a cornucopian frame is optimistic that science inevitably solves all of our problems, such as replacing seemingly finite resources. In other words, science is said to create new resources and propel the advancement of society. Precise wording for the frames is located in Appendix A.

Based on a survey question I asked before starting the framing experiment, I was able to obtain a rough measure of how strongly these values about science might resonate with Americans. Although the conservative humanist position is only held by a minority (just more than 10 percent thinks that sci-

ence predominately creates problems), a large percentage (more than 40 percent think that science equally creates and solves problems) is clearly ambivalent about the merits of science.

I nevertheless anticipated that the value frames might not be effective, so I also included mention of specific risks and benefits about nanotechnology in six of the nine framing conditions. Thus, the first frame is a conservative humanist one and the second and third frames add mention of different types of potential risks of nanotechnology to the values espoused by conservative humanists. Likewise, the fourth frame is a cornucopian one, and the fifth and sixth frames add mention of different kinds of potential benefits of nanotechnology to the values promoted by cornucopians. The risks mentioned in the second and third frames are health risks and then multiple dimensions of risks (arms race, weapons, environmental, and economic), respectively. Potential benefits identified in the fifth and sixth frames are, conversely, health benefits and then multiple dimensions of benefits (energy, consumer goods, health, and environmental), respectively.

The final three framing conditions, seven through nine, include mention of both risks and benefits. These two-sided frames match each of the three risk frames with each of their logical opposites among the benefits frames. Thus, respondents in the seventh framing condition hear both the conservative humanist and the cornucopian frames. Respondents in the eighth framing condition listen to the health risks and the health benefits frames. In the final framing condition, respondents hear about multiple kinds of risks and benefits.

### *Dependent Variables*

Following studies about risk perceptions and opinions about GMF, the primary dependent variable in this study is a question asking respondents to predict whether the risks of nanotechnology will be greater than, equal to, or less than benefits (precise wording and variable coding for these variables is located in Appendix B). A second dependent variable measures how much respondents trust industry officials to minimize risks to humans. I ask this question because trust plays an important role in determining citizens' acceptance of new technologies (Frewer, Miles, and Marsh 2002), especially when the issue is complex and knowledge is low (Siegrist and Cvetkovich 2000). The third, fourth, and fifth dependent variables measure three types of emotions that respondents might feel about nanotechnology: hope, anger, and worry. According to some psychologists, emotional reactions to people, events, or issues supplement and are often superior to cognition at explaining opinions (Loewenstein and Lerner 2003). Emotions can also be framed. In a

**TABLE 1**  
**Respondents' Perceptions of Risks and**  
**Benefits of Nanotechnology, by Framing Condition**

<i>Condition</i>	<i>Risks &gt; Benefits</i>	<i>Risks = Benefits</i>	<i>Risks &lt; Benefits</i>
Control group	20(64)	40(125)	40(126)
Conservative humanism	23(30)	35(46)	42(54)
Cornucopian	14(18)	46(80)	41(53)
Health risks***	32(42)	37(48)	31(40)
Health benefits***	18(23)	28(36)	54(69)
Multiple risks***	32(42)	35(46)	33(43)
Multiple benefits**	12(15)	41(53)	48(63)
Conservative humanism versus cornucopian*	29(38)	37(49)	34(45)
Health risks versus health benefits	22(28)	39(51)	39(51)
Multiple risks versus multiple benefits	20(27)	43(57)	37(50)

NOTE: Entries are percentages; number of respondents is in parentheses.

\*\*\* $p < .05$ ; \*\* $p < .10$ ; \* $p < .15$ , Pearson Chi-Square Tests (responses in each of the framing conditions are compared to the control group).

study of the 1992 Los Angeles riots, for example, Gross and D'Ambrosio (2004) find significant framing of respondents' emotions.

## **Results**

I begin the analysis by comparing respondents' opinions about the risks of nanotechnology versus its benefits across each of the nine framing conditions compared to the control group. Then, I examine whether framing affected respondents' trust in industry leaders. Last, I analyze framing effects on respondents' emotions about nanotechnology. I present these results in cross-tabular form, opinions by framing conditions, and use Pearson's Chi-Square to test for significant differences in respondents' opinions compared to the control group.

According to the results presented in Table 1, one-sided frames are consistently effective, but only when they identify specific risks or benefits about nanotechnology. Neither frame that promoted a particular version of the merits of science alone—conservative humanism or cornucopian—was influential. All four additional one-sided frames, however, created different perceptions about the balance between risks and benefits. Both frames including health risks and multiple kinds of risks about nanotechnology increased the percentages believing that risks will exceed or be equal to benefits. Similarly,

**TABLE 2**  
**Respondents' Trust in Business Leaders**  
**Minimizing Risks to Humans, by Framing Condition**

<i>Condition</i>	<i>Not Much Trust</i>	<i>Some or a Lot of Trust</i>
Control group	58(190)	42(140)
Conservative humanism	69***(92)	31(42)
Cornucopian	67**(90)	33(44)
Health risks	62(83)	38(51)
Health benefits	58(78)	42(56)
Multiple risks	74***(98)	26(35)
Multiple benefits	56(75)	44(58)
Conservative humanism versus cornucopian	58(78)	42(56)
Health risks versus health benefits	52(70)	48(64)
Multiple risks versus multiple benefits	55(73)	45(61)

NOTE: Entries are percentages; number of respondents is in parentheses.

\*\*\* $p < .05$ ; \*\* $p < .10$ ; \* $p < .15$ , Pearson Chi-Square Tests (responses in each of the framing conditions are compared to the control group).

both cornucopian frames that included specific benefits about nanotechnology resulted in more people expecting the benefits to surpass the risks. Interestingly, risk frames never resulted in a plurality of respondents believing that the risks of nanotechnology would be more likely than its benefits. Instead, respondents in the risk frames conditions were simply more skeptical about potential benefits. Conversely, framing nanotechnology as beneficial resulted in an actual majority of respondents in the health benefits condition saying that benefits would prevail, and a solid plurality in the multiple benefits condition saying the same thing.

As expected, opinion change was less likely to occur when respondents were in one of the two-sided framing conditions. Respondents' perceptions about nanotechnology were significantly different in just one of these three two-sided framing conditions. In this one case, perceptions of risks unexpectedly increased when respondents heard both the conservative humanist and cornucopian frames. This appears to be a statistical anomaly because neither of these particular frames was associated with significant opinion change when they were one sided. Overall, then, the general pattern of results for two-sided frames is consistent with the claim that framing effects tend to occur because respondents are exposed to just one side of a debate.

On the second dependent variable, respondents' trust in industry leaders, I find slightly fewer framing effects. Yet, when framing effects exist, they always result in respondents expressing less trust. These results are presented in Table 2.

**TABLE 3**  
**Respondents' Emotions about Nanotechnology,**  
**by Framing Condition**

<i>Condition</i>	<i>Hope</i>	<i>Anger</i>	<i>Worry</i>
Control group	83(275)	18(59)	26(84)
Conservative humanism	78*(104)	17(23)	25(33)
Cornucopian	81(109)	13(17)	23(31)
Health risks	73***(98)	13(17)	31(41)
Health benefits	88(118)	9***(12)	25(34)
Multiple risks	81(108)	17(23)	34**(46)
Multiple benefits	87(117)	9***(12)	27(36)
Conservative humanism versus cornucopian	79(106)	13(18)	25(34)
Health risks versus health benefits	84(112)	10***(14)	31(41)
Multiple risks versus multiple benefits	84(112)	13(18)	31(41)

NOTE: Entries are percentages; number of respondents is in parentheses.

\*\*\* $p < .05$ ; \*\* $p < .10$ ; \* $p < .15$ , Pearson Chi-Square Tests (responses in each of the framing conditions are compared to the control group).

According to these data, trust is remarkably low regardless of condition, and it drops even further in several of the one-sided framing conditions. Just 31 percent of respondents in the conservative-humanism frame reported having some or a lot of trust, for example, compared to 42 percent in the control group. A second risk frame about multiple types of risks also caused a significant decline in trust. Strikingly, only 26 percent of respondents in this condition said they had much trust, a decline of 16 percent compared to the control group. (Oddly, the health risks frame was ineffective, for which there is no good explanation.)

Several other results stand out. First, all three of the two-sided frames failed to produce significantly different opinions. Again, this finding is in line with prior research that shows framing effects are eliminated when both frames are heard. Second, benefits framing was ineffective. Overall, then, trust was often but not always affected by risk framing, and these effects do not persist when respondents hear counter framing. Yet, the decline in trust is very interesting because the risks used in these frames do not imply industry leaders are at fault; apparently, respondents simply assume they are responsible. This suggests that opponents of nanotechnology might find it easier to attack it on grounds that you "can't trust business to keep it safe" rather than attack it on some of its own specific characteristics.

For the last set of dependent variables, I find that framing affects feelings of hope, anger, and worry. While framing effects on emotions were consistent, their sizes were not especially large and respondents' feelings never

completely reversed. Respondents did not report feeling hopeful in the control condition, for example, and then claim they were unhopeful in any of the framing conditions. Similarly, feelings of anger and worry never approached majority status. Also, despite the systematic pattern to the framing effects, no specific frame influenced more than one type of emotion. These results are presented in Table 3.

Framing nanotechnology as risky resulted in respondents reporting more negative feelings. More precisely, risk frames caused respondents to feel less hopeful about nanotechnology and in one case it increased their worry about it. For example, the conservative humanism frame and the health-risks frame caused fewer respondents to feel hopeful about nanotechnology, 78 percent and 73 percent, respectively, compared to 83 percent in the control group. Yet, compared to the control group, the maximum size of a framing effect on any emotion was only  $\pm 10$  percent. Another important aspect to these effects is that hope overwhelms the negative emotions. Even when it declines in a risk-framing condition, for example, at least 73 percent of respondents remain hopeful about nanotechnology. Likewise, exposure to the multiple-risks frame increased respondents' worry about nanotechnology, but even then only about one-third of them felt this way, the highest percentage of worried respondents in any condition.

In contrast to the frames for trust, the benefit frames for emotions produced a similar number of effects as risk frames. When nanotechnology was framed as beneficial, respondents reported feeling less angry about nanotechnology. While 18 percent of respondents in the control group said they were angry about nanotechnology, the highest percentage of respondents in any benefits condition saying they were angry was 13 percent, and in two conditions that percentage was just 9 percent. This result is impressive considering it is difficult for any stimulus to reduce the already low percentage of respondents angry about nanotechnology in the control group.

One final observation worth noting is that risk frames affected the measure of a positive emotion (hope) while benefits frames affected only negative emotions (anger and worry). With a single exception, respondents in antinotechnology-framing conditions reported less positive about nanotechnology instead of increased negative emotions. Conversely, respondents in the pronanotechnology conditions said they felt less negative about nanotechnology rather than more hopeful. Importantly, these patterns do not merely reflect ceiling and floor effects. Feelings of hopefulness were high, for example, so it might appear that risk framing worked only because it would be easier to produce a decline than an increase in feeling hopeful. Yet, negative emotions about nanotechnology were uncommon in the control

group and they became even rarer after listening to potential benefits, which should not have happened if floor effects were present.

### *Discussion*

Somewhat expectedly, philosophical frames about the merits of science were only sporadically influential. Successful framing usually required the mention of specific risks and benefits about nanotechnology. In the instances when philosophical frames were effective, the conservative humanism position was more likely to be influential. As would be expected by the literature, frames including risks of nanotechnology were more successful than ones mentioning benefits; however, the differences were not overwhelming. Hearing about the risks of nanotechnology, for example, lowered respondents' trust in industry leaders and they reported feeling less hopeful about it. Respondents exposed to risk frames were also less likely to expect benefits. Benefits framing had less impact. For example, framing nanotechnology in terms of its benefits did not increase respondents' trust in industry leaders. However, respondents in the benefit-framing conditions were somewhat less angry and less worried about nanotechnology and more likely to think its benefits would outweigh its costs.

Two additional findings have broad implications for future mass opinion about nanotechnology. One is that two-sided frames generally failed to produce opinion change, and a second is that framing effects, in general, were not especially large. Prior studies might have found more robust framing effects because they present respondents with only one possible frame. The typical lack of significant opinion change in this study when respondents are exposed to a two-sided frame suggests that opinions about nanotechnology will be more likely to move in a biased information environment where one side of the debate is able to effectively monopolize the framing of the issue to their advantage. In this study, for example, risk frames were somewhat more effective than benefit frames, but this apparently occurs only when risk and benefit frames are heard in isolation of one another. In a balanced information environment, then, ambivalence rather than opinion change is a more plausible outcome.

Another reason to expect future opinion change about nanotechnology to be restrained is that respondents' perceptions were not fundamentally altered in this study even though they were significantly affected. Opinions never completely reversed from support to opposition, for example, or from untrusting to trusting. Likewise, respondents were less hopeful after hearing a

risk frame, but they never became unhelpful. In fact, the typical difference between opinions in the control group and a successful framing condition was usually around 10 percent. To be sure, these differences are meaningful, but they do not portend an immense advantage for either side of the debate. The implication is that unless citizens are exposed to different frames and information that are qualitatively different than those used in this study, we should not expect a sudden or massive shift in public opinion about nanotechnology.

The generally limited size of the framing effects reported here was anticipated for several theoretical reasons, but, from another perspective, these effects were maybe not that small at all. If the control group is discarded from the analysis, which most framing studies do, then the differences between opinions across different framing conditions are substantial. I conclude by speculating about two ways that future framing effects on nanotechnology could be bigger.

#### *Sources of Frames and Elite Polarization*

Frames in this study were not sourced, because the additional variable would have overburdened an already complex experimental design. In the real world, however, frames are rarely read or heard without attribution. Usually, social, political, or economic elites are the source of issue frames, which is important because citizens rely on elites as a primary heuristic when forming opinions about issues (Zaller 1992). Credible elites will undoubtedly enhance the effectiveness of framing (Druckman 2001a; Kuklinski and Hurley 1994). In Britain, for example, Prince Charles's criticisms of nanotechnology probably gave credence to critics' complaints, whereas opposition elites in the United States are unknown to most people. When elites are unified on an issue, public opinion is expected to follow along. If elites disagree, however, public consensus can disappear too.

#### *Kinds of Risks*

Risk perception research reveals that citizens, in contrast to experts, place potential hazards on a two-dimensional space, one end anchored by the magnitude of the risk ("dread") and the other by its controllability (Slovic 1987). Researchers consistently find that the social response to risk maps onto the placement of hazards in this two-dimensional space. The more catastrophic and the less controllable a hazard is perceived to be, the more fearful people will be about it. This might explain why 12 percent of respondents in this survey named self-replicating nanorobots, which is an often-ridiculed scenario, as the risk of nanotechnology they most wanted to avoid (Cobb and

Macoubrie 2004; Cobb and Hamlett 2005). Regardless of the actual possibility of a “grey-goo” scenario, it conjures up images of both dread and a lack of control. Thus, if the specific risks identified in this study were not perceived as being catastrophic and they were seen as controllable, other kinds of risk frames might very well cause greater opinion change.

### *Conclusion*

The results presented here suggest that Americans’ opinions about nanotechnology are malleable but that there are limits to changing their opinions. Americans begin with a basically positive view of nanotechnology and—despite its weak factual basis—this view remains surprisingly constant even when exposed to negative frames. Other main findings include: (1) even in an area with opinions based on little specific knowledge, general frames (overall attitudes toward science) produced less effect; (2) positive frames were sometimes almost as efficacious as negative ones, in contrast to past findings; and (3) trust of elites was low and easily driven lower by negative frames. Studies like this one provide important insights into the effect of framing on a broad category of public policy—complex issues where the public is ill-informed and knows it. Thus, the findings here may well have implications for framing in other areas, including tax policy, weapons policy, and complex social programs.

### **Appendix A: Wording for Framing Conditions**

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Condition 1: (Control group) “Nanotechnology is the process of manipulating materials at the minuscule level of atoms and molecules. Another way to say this is that nanotechnology refers to the manipulation of living and non-living matter at the level of the nanometer, one billionth of a meter.”

Condition 2: (Conservative Humanist) Control-group statement plus: “Some scientists warn that nanotechnology will not be a ‘silver bullet’ for resolving the wants and needs of mankind. They say we have to avoid the seduction of technology as a cure for everything because the human condition cannot be conquered by modern technology.”

Condition 3: (Conservative Humanist/Health Risks) Control-group statement plus Conservative Humanist Frame plus: “They say nanotechnology might be dangerous to humans. Researchers have discovered that nanoparticles are showing up in the livers of research animals, they can seep into living cells, and perhaps piggyback on bacteria to enter the food chain.”

Condition 4: (Conservative Humanist/Multiple Risks) Control-group statement plus Conservative Humanist frame plus: “They say nanotechnology might cause competing nations to enter a disruptive and unstable arms race. Sinister weapons and surveillance devices could be made small, cheap, powerful, and very numerous. Cheap manufacturing and duplication of designs could lead to economic upheaval. And overuse of inexpensive products could cause widespread environmental damage.”

Condition 5: (Cornucopian) Control group statement plus: “Some scientists say that we are not optimistic enough about nanotechnology. They say it is not possible to project the fantastic worlds which nanotechnology will continue to open up to us in the coming years. Science inevitably leads to human progress and the Earth is inexhaustible because new technologies create new resources.”

Condition 6: (Cornucopian/Health Benefits) Control-group statement plus Cornucopian frame plus: “They say nanotechnology will improve human health, physical and mental abilities. Researchers expect to create new medical tools to detect diseases earlier and treat them more effectively; such as implanting tiny drug delivery systems that automatically administer drugs that go where they are needed most.”

Condition 7: (Cornucopian/Multiple Benefits) Control-group statement plus Cornucopian frame plus: “They say nanotechnology can make solar power a primary and abundant energy source; greatly reduce infectious diseases; make computers and display devices stunningly cheap; make stronger fabrics and safer bumpers on cars; and even make products with far less waste to protect the environment.”

Condition 8: (Conservative Humanist vs. Cornucopian) Control-group statement plus: “Some scientists warn that nanotechnology will not be a ‘silver bullet’ for resolving the wants and needs of mankind. They say we have to avoid the seduction of technology as a cure for everything because the human condition cannot be conquered by modern technology. Other scientists say that we are not optimistic enough about nanotechnology. They say it is not possible to project the fantastic worlds which nanotechnology will continue to open up to us in the coming years. Science inevitably leads to human progress and the Earth is inexhaustible because new technologies create new resources.”

Condition 9: (Health Risks vs. Health Benefit) Control-group statement plus: “Some scientists say nanotechnology might be dangerous to humans. Researchers have discovered that nanoparticles are showing up in the livers of research animals, they can seep into living cells, and perhaps piggyback on bacteria to enter the food chain. Other scientists say nanotechnology will improve human health, physical and mental abilities. Researchers expect to create new medical tools to detect diseases earlier and treat them more effectively; such as implanting tiny drug delivery systems that automatically administer drugs that go where they are needed most.”

Condition 10: (Multiple Risks vs. Multiple Benefits) Control-group statement plus: “Some scientists say nanotechnology can make solar power a primary and abundant energy source; greatly reduce infectious diseases; make computers and display devices stunningly cheap; make stronger fabrics and safer bumpers on cars; and even make products with far less waste to protect the environment. Other scientists say nanotechnology might cause competing nations to enter a disruptive and unstable

arms race. Sinister weapons and surveillance devices could be made small, cheap, powerful, and very numerous. Cheap manufacturing and duplication of designs could lead to economic upheaval. And overuse of inexpensive products could cause widespread environmental damage.”

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### **Appendix B: Question Wording, Variables, and Original Coding**

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RISKS vs. BENEFITS: “There is a lot of talk about the potential risks and benefits of nanotechnology. What do you think? Do you think the benefits of nanotechnology will outweigh the risks, the risks will outweigh the benefits, or will the risks and benefits be about equal?” (1 = risks > benefits, 2 = risks = benefits, 3 = benefits > risks)

TRUST: “How much do you trust business leaders within the nanotechnology industry to minimize potential risks to humans? Do you trust them a lot, some or not that much?” (1 = A lot, 2 = Some, 3 = Not that much)

EMOTIONS (WORRY, HOPE, ANGER): “The next set of questions asks about emotions you might feel. Are you [worried/hopeful/angry] about nanotechnology? How [worried/hopeful/angry] are you? (0 = No, not [worried, hopeful, angry], 1 = Yes, a little [worried, hopeful, angry], 2 = Yes, somewhat [worried, hopeful, angry], 3 = Yes, very [worried, hopeful, angry])

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### **Notes**

1. One of the most widely known research traditions on framing focuses on how different but logically equivalent words or phrases can cause individuals to change their preferences, seemingly in violation of the axiom of rational choice theory (Tversky and Kahneman 1981).

2. Every household in the continental United States with a land phone line had an equal probability of being contacted. The minimum response rate was 38 percent using standard definition 1 from the American Association for Public Opinion Research.

### **References**

- Bainbridge, W. 2002. Public attitudes toward nanotechnology. *Journal of Nanoparticle Research* 4(6): 461–470.
- Brewer, P. 2001. Value words and lizard brains: Do citizens deliberate about appeals to their core values? *Political Psychology* 22(1): 45–64.
- Carmines, E., and J. Stimson. 1980. The two faces of issue voting. *American Political Science Review* 74(1): 78–91.
- Chong, D. 2000. *Rational lives: Norms and values in politics and society*. Chicago: University of Chicago Press.

- Cobb, M., and P. Hamlett. 2005. Public Deliberation Problems: Polarization Cascades and Structured Deliberations. Paper presented at the annual meeting of the American Political Science Association, Washington, D.C.
- Cobb, M., and J. Kuklinski. 1997. Changing minds: Political arguments and political persuasion. *American Journal of Political Science* 41(1): 88–121.
- Cobb, M., and J. Macoubrie. 2004. Public perceptions about nanotechnology: Risks, benefits and trust. *Journal of Nanoparticle Research* 6(4): 395–405.
- Druckman, J. 2001a. On the limits of framing effects: Who can frame? *Journal of Politics* 63(4): 1041–1066.
- Druckman, J. 2001b. The implications of framing effects for citizen competence. *Political Behavior* 23(3): 225–256.
- Druckman, J. 2004. Political preference formation: Competition, deliberation, and the (ir)relevance of framing effects. *American Political Science Review* 98(4): 671–686.
- Druckman, J., and K. Nelson. 2003. Framing and deliberation: How citizens' conversations limit elite influence. *American Journal of Political Science* 47(4): 729–745.
- Entman, R. 1993. Framing: Toward clarification of a fractured paradigm. *Journal of Communication* 43(4): 51–58.
- Fiske, S., and S. Taylor. 1991. *Social cognition*. 2d ed. New York: McGraw-Hill.
- Frewer, L., S. Miles, and R. Marsh. 2002. The media and genetically modified foods: Evidence in support of social amplification of risk. *Risk Analysis* 22(4): 701–711.
- Gamson, W. 1992. *Talking politics*. New York: Cambridge University Press.
- Gaskell, G., M. Bauer, J. Durant, and N. Allum. 1999. Worlds apart? The reception of genetically modified foods in Europe and the U.S. *Science* 285 (5426): 384–387.
- Greene, S. 2004. The psychological perspective: 1950's to the present. In *Public opinion and polling around the world: A historical encyclopedia*, edited by J. Geer, 9–26. Santa Barbara, CA: ABC-CLIO.
- Gross, K., and L. D' Ambrosio. 2004. Framing emotional responses. *Political Psychology* 25(1): 1–29.
- Haider-Markel, D., and M. Joslyn. 2001. Gun policy, opinion, tragedy, and blame attribution: The conditional influence of issue frames. *Journal of Politics* 63(2): 523–533.
- Holden, C. 2004. California's proposition 71 launches stem cell gold rush. *Science* 306(5699): 1111.
- Joslyn, M., and D. Haider-Markel. 2002. Framing effects on personal opinion and perceptions of public opinion: The cases of physician-assisted suicide and social security. *Social Science Quarterly* 83(3): 690–706.
- Kahneman, D., and A. Tversky. 1979. Prospect theory: An analysis of decision under risk. *Econometrica* 47(2): 313–327.
- Kuklinski, J., and N. Hurley. 1994. On hearing and interpreting political messages: A cautionary tale of citizen cue-taking. *Journal of Politics* 56(3): 729–51.
- Lau, R. 1985. Two explanations for negativity effects in political behavior. *American Journal of Political Science* 29(1): 119–138.
- Lewenstein, B. 2004. What counts as a “social and ethical issue” in nanotechnology? *International Journal for Philosophy of Chemistry* 11(1): 5–18.
- Loewenstein, G., and J. Lerner. 2003. The role of affect in decision making. In *Handbook of affective science*, edited by R. Davidson, H. Goldsmith, and K. Scherer, 619–642. Oxford: Oxford University Press.
- Macoubrie, J. Forthcoming. Nanotechnology: Public concerns, reasoning, and trust in government. *Public Understanding of Science*.
- Miller, J., and J. Krosnick. 2000. News media impact on the ingredients of presidential evaluations. *American Journal of Political Science* 44(2): 301–315.

- Monteiro-Riviere, N., R. Nemanich, A. Innan, Y. Wang, and J. Riviere. 2005. Multi-walled carbon nanotube interactions with human epidermal keratinocytes. *Toxicology Letters* 155(3): 377–384.
- National Science Board. 2002. *Science and engineering indicators-2002*. Arlington, VA: National Science Foundation (NSB-02-1).
- National Science and Technology Council. 2000. *National nanotechnology initiative: Leading to the next industrial revolution*. A report by the Interagency Working Group on Nanoscience, Engineering and Technology, Washington, D.C.
- Nelson, T. E., and Z. M. Oxley. 1999. Issue framing effects on belief importance and opinion. *Journal of Politics* 61(4): 1040–1067.
- Nelson, T. E., Z. M. Oxley, and R. Clawson. 1997. Toward a psychology of framing effects. *Political Behavior* 19(3): 221–246.
- Oberdorster, E. 2004. Manufactured nanomaterials (Fullerenes, C60) induce oxidative stress in the brain of juvenile largemouth bass. *Environmental Health Perspectives* 112(10): 1058–1062.
- Page, B., and R. Shaprio. 1992. *The rational public*. Chicago: The University of Chicago Press.
- Petty, R., and J. Cacioppo. 1986. *Communication and persuasion: Central and peripheral routes to attitude change*. New York: Springer-Verlag.
- Popkin, S. 1994. *The reasoning voter*. Chicago: University of Chicago Press.
- Priest, S. 2000. U.S. public opinion divided over biotechnology? *Nature Biology* 18: 939–42.
- Roco, M. 2003. Broader societal issues of nanotechnology. *Journal of Nanoparticle Research* 5(2): 181–89.
- Roco, M., and W. Bainbridge, eds. 2001. *Societal implications of nanoscience and nanotechnology*. National Science Foundation Report. Boston: Kluwer.
- Siegrist, M., and G. Cvetkovich. 2000. Perception of hazards: The role of social trust and knowledge. *Risk Analysis* 20(5): 713–720.
- Slovic, P. 1987. Perception of risk. *Science* 236:280–85.
- Slovic, P. 1993. Perceived risk, trust, and democracy. *Risk Analysis* 13(6): 675–682.
- Steward, W., T. Schneider, J. Pizarro, and P. Salovey. 2003. Need for cognition moderates responses to framed smoking-cessation messages. *Journal of Applied Social Psychology* 33(12): 2439–2464.
- Toumey, C. 2004. Narratives for nanotech: Anticipating public reactions to nanotechnology. *Techne* 8(2): 88–116.
- Tversky, A., and D. Kahneman. 1981. The framing of decisions and the psychology of choice. *Science* 211(4481): 453–58.
- White, M., S. Paul, M. Buehner, and A. Haye. 2003. Trust in risky messages: The role of prior attitudes. *Risk Analysis* 23(4): 717–726.
- Zaller, J. 1992. *The nature and origins of mass opinion*. Cambridge: The Cambridge University Press.
- Zaller, J., and S. Feldman. 1992. A simple theory of the survey response: Answering questions versus revealing preferences. *American Journal of Political Science* 36(1): 579–616.

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