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HOW FRAMES CAN UNDERMINE SUPPORT FOR SCIENTIFIC ADAPTATIONS: POLITICIZATION AND THE STATUS-QUO BIAS

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Abstract The politicization of science is a phenomenon that has sparked a great deal of attention in recent years. Nonetheless, few studies directly explore how frames that highlight politicization affect public support for scientific adaptations. We study how frames that highlight politicization affect support for using nuclear power, and test our hypotheses with two experiments. We find, in one study, that politicizing science reduces support for nuclear power and renders arguments about the environmental benefits of nuclear energy invalid, regardless of whether there is a reference to consensus scientific evidence. We find, in a second study, that reference to the potential health risks associated with using nuclear power also decreases support in the presence of additional frames that highlight either science's progress or its politicization. In the end, our findings suggest that a status-quo bias prevails that, under some circumstances, can serve as a significant impediment to generating public support for scientific innovations.

Over the last quarter-century, scientific adaptations and their concomitant consequences have accelerated at an amazing pace. This has led to debates about climate change, genetically modified food, nanotechnology, and sustainable

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energy sources. How each of these debates evolves depends in critical ways on public opinion. Indeed, politicians rarely advocate scientific adaptations without the support (or at least not ardent opposition) of their constituents, and scientific technologies rarely survive the regulatory process or succeed in the marketplace without public acceptance.

This makes the recent dramatic growth of the field of public opinion about science and science communication unsurprising. One of the key lessons of this work is that "framing is an unavoidable reality of the science communication process" (Nisbet and Scheufele 2009, 1771). Framing refers to placing emphasis on certain considerations instead of others in a communication. For example, one might emphasize the positive environmental as opposed to potential negative health consequences of generating nuclear power. This, in turn, often shapes opinions about whether it is desirable to develop additional nuclear plants.

In this paper, we extend extant research in two ways. First, we employ more realistic frames when it comes to the study of exposure to science-based communications and public opinion—that is, frames that do not simply focus on one dimension such as the environmental or health implications of nuclear energy. Indeed, we employ a realistic portrayal of what frames actually look like in action (i.e., they contain multiple dimensions; see Chong and Druckman [2011]). We explore three of the key components of frames related to scientific adaptations: politicization, consequences (e.g., environment, health), and technical evidence (e.g., scientific literacy). Second, we hypothesize and find that exposure to certain frames can decrease support for scientific adaptations. This effect can stem from exposure to frames that highlight the politicization of science itself or, in at least some cases, frames that evoke a negativity bias. We are the first to provide direct causal evidence on how exposure to a frame that politicizes science shapes public opinion.

Framing Effects

The term "frame" has varied meanings across disciplines, including cognitive science, economics, sociology, psychology, and more (see Druckman 2011). When it comes to political communication, the prototypical definition is that a framing effect occurs when a communication changes a person's attitude toward an object (e.g., policy) by increasing the weight given to a subset of relevant considerations (Druckman 2001a). A classic example is an experiment in which participants are asked if they would allow a hate group to stage a public rally. Those participants randomly assigned to read an editorial emphasizing free speech express greater support for allowing the demonstration compared to those who read an editorial about the risks it might present to public safety (Nelson, Oxley, and Clawson 1997). Framing is effective in this instance because the communication causes the individual to change the

weight he/she gives to a specific dimension of considerations as a result of exposure to the frame, leading him/her to distinct opinions.

We find ourselves in agreement with Iyengar (2010), however, about the ambiguity of the term "framing": "the boundaries between framing and other forms of media or elite influence on public opinion have become blurred. Framing is often indistinguishable from priming or persuasion" (190). Further, he points out that "frames not only vary the perspective or underlying dimensions for considering an event…but also differ in several other respects…[representing] multiple and hidden confounded variables" (188). While in some ways, one may construe this as a source of substantial confusion and underdevelopment, we view it more as an opening to clarify a field overwrought with jargon (see Druckman, Kuklinski, and Sigelman 2009) and, as such, we treat framing in a broad sense. We focus attention on alternative considerations that include distinct considerations encountered in the political and scientific environment. This is a critical point, in fact, because most studies—in light of the aforementioned ambiguity—have employed what in reality are relative simplistic frames in two ways.

First, virtually all framing effect studies include frames that contain single dimensions instead of multiple parts (i.e., considerations that may or may not be linked). In reality, rarely does a person encounter a single dimension of emphasis (e.g., a communication highlighting *only* free speech or public safety related to the aforementioned study of whether to allow a hate-group rally) in the absence of additional information and/or evidence. Chong and Druckman (2011) found that across fourteen distinct national, state, and local issues over time, media coverage typically employs at least two distinct frames in a single news article, and that "over 35% of the articles contained more than two frames, contrasting even more sharply with current experimental designs" (253).

Second, while most studies largely focus on understanding how exposure to a single frame affects opinion, some have begun to introduce competition between multiple frames in the opinion formation process (e.g., public safety versus free speech; see for example Sniderman and Theriault [2004]; Chong and Druckman [2007]). That said, only recently has science-oriented work recognized competition between frames—Aklin and Urpelainen (2013) state that "previous survey studies of [science] framing have not considered the implications of counter framing for public opinion" (1) (although see Chong and Druckman [2013]). The general finding from the scant work on competitive framing is that the "strongest" frame wins, or has a larger impact on opinion in a competitive information context, and if two competing frames are of equal strength they cancel out the impact of each individual frame (Chong and Druckman 2007; Druckman 2011).

The problem here is how strength is defined—that is, what makes a frame strong? In an unsatisfying way, the main approach for measuring strength is simply to ask a distinct group of participants what frames or arguments they

find most "compelling." Of course, that leaves unclear the theoretical status of why it is strong or persuasive. This same problem also appears in studies of persuasion; O'Keefe (2002) states: "A strong-argument message is defined as 'one containing arguments such that when subjects are *instructed* to think about the message, the thoughts that they generate are predominantly favorable...[research] has postponed the question of what special qualities make arguments persuasive by defining argument quality as an empirical matter' (Petty and Cacioppo 1986, 32)" (147; (italics in original).

In what follows, we employ a communication that contains three dimensions that capture the reality of the debates we study, at least with respect to scientific adaptations. Additionally, we aim to develop theoretically grounded hypotheses about frames likely to exert the most substantial impact on public opinion toward scientific adaptations, thereby beginning to unpack what makes a frame strong in this domain (see Aarøe 2011; Arceneaux 2012).

Framing Science

As mentioned, and now widely recognized in the science communication/opinion field, framing is a key to opinion formation toward science-related issues (e.g., Bauer, Allum, and Miller 2007; Nisbet and Mooney 2007; Nisbet 2007; Nisbet and Scheufele 2009). Yet, neither citizens nor frames are as simplistic as previously studied: frames organize the world for citizens, but citizens are not unable to process multiple pieces of information at once. For instance, a recent study on the determinants of perceptions of risk associated with climate change finds evidence that high levels of numeracy—that is, the capacity to understand and make use of numerical information—actually *increases* cultural polarization between groups predisposed to support and oppose emergent technologies (Kahan, Jenkins-Smith, and Braman 2012). Indeed, one can turn to Miller's (1956) famous magic number of 7 ± 2 as the number of objects humans can hold in working memory. This is not to say that citizens possess the motivation to comb through mountains of scientific information, but only to make clear that they have the capacity to process more than a single dimension simultaneously—and that leads us to highlight *three* key, often employed, and realistic aspects of science framing:

POLITICIZATION OF SCIENCE

Few trends in science have received as much recent attention as has its politicization—that is, when political interests shape the presentation of scientific facts to fit distinct models of "reality" for self-interested reasons (Pielke 2007; Oreskes and Conway 2010). This occurs when, for instance, advocates of a particular agenda selectively cite evidence to support their favored position (Pielke 2007; Goldberg 2012). The paradigmatic example of politicization is the "debate" over the existence of global warming (see Oreskes and Conway

2010; Schuldt, Konrath, and Schwarz 2011). The consequences and potential implications are captured by a recent editorial in *Nature* (2010) that argues that "there is a growing anti-science streak…that could have tangible societal and political impacts" (133). We do not study politicization *per se* in this fashion but rather use it as an element of a frame by reminding people that much of contemporary science is politicized; in other words, we use a *politicization* frame. In short, frames that highlight politicization introduce *uncertainty regarding whether one can trust science-based arguments.*

Hypothesis 1: Individuals exposed to a frame that highlights the politicization of science will become less supportive of a scientific adaptation, all else constant.

We also employ an intriguing counterfactual frame to politicization that emphasizes the promise of the scientific method. Specifically, we include frames in different studies that emphasize the progress of science as a method for generating knowledge. Given the lack of prior work in this specific area, we do not formally hypothesize how exposure to a frame that highlights this positive aspect of science will shape opinions toward nuclear energy. Nonetheless, we suspect that (in contrast to politicization) it should increase the strength of arguments and evidence, thereby increasing the impact of exposure to positive frames supportive of nuclear energy.

CONSEQUENCE FRAME

Perhaps the most prominent usage of a frame is to highlight a particular consequence of a policy, such as how it might affect one's health, the environment, the economy, or the nation's security—common dimensions highlighted in debates over the use of nuclear energy (Ansolabehere and Konisky 2009). The idea is that frames deemed strong will dominate in competition, unless frames of equal strength and in an opposing direction are in competition, in which case the frames will cancel out each other in terms of their individual impact in isolation (Chong and Druckman 2007).

Hypothesis 2a: A frame deemed strong will move opinion in a positive direction toward support for using a scientific adaptation if it is a supportive frame or in a negative direction if it is a negative frame, all else constant.

That said, most of the frames employed in extant studies, while differing in direction, are not relative to a clear status quo *per se*. We propose that when a clear status quo exists, a negative frame will overwhelm any competition, due to the well-known negativity bias. This can directly generate a status-quo bias or, alternatively, uncertainty can generate anxiety (Caplin and Leahy 2001),

leading to greater weight being given to arguments consistent with the negative frame (Arceneaux 2012). The evidence for this type of status-quo bias in experimental settings is widespread and long-standing (e.g., Samuelson and Zeckhauser 1988; Kahneman, Knetsch, and Thaler 1991). Recently, this was directly tested and supported in a framing context by Arceneaux (2012), who shows that exposure to messages that produce anxiety triggers cognitive biases. He finds that individuals who are exposed to framed communications that put one in a negative state generate anxiety, which makes people become "less likely to accept the recommendations of arguments" that are inconsistent with the negative frame (Arceneaux 2012, 273).

Hypothesis 2b: Exposure to a negative frame will cause individuals to resist other information in a communication and hold to the status quo if one exists, all else constant.

EVIDENCE

The final dimension we examine is scientific evidence. There is a fair amount of research on how evidence affects opinions, and perhaps the results are not as strong as one might expect. Contrary to the scientific literacy model, the citation of evidence does not consistently enhance support for scientific adaptations (i.e., compared to when the same supportive information is provided without evidence; e.g., see Druckman and Bolsen [2011]). However, on the whole, it does have an effect (Druckman and Bolsen 2011; O'Keefe 2002, 186–87), especially when the source of the evidence is credible (Druckman 2001b). One important element, when it comes to the scientific literacy model (Miller 1983, 2004), is that any evidence be cited as being supported by a consensus of scientists (for a discussion of that model, see Nisbet [2007]).

Hypothesis 3: Individuals will become more supportive of an issue in the presence of a citation to evidence supported by a consensus of scientists, all else constant.

We expect that when our hypotheses come into conflict with one another, such as when an individual receives a supportive consequence frame with or without evidence but also joined with a politicization frame, the uncertainty generated by politicization will overpower the positive argument and evidence. It will create uncertainty about whether or not to trust science-based arguments and evidence in this particular instance.

MODERATING AND MEDIATING FRAMING EFFECTS

We additionally have brief and straightforward hypotheses regarding a moderator and a potential mediator of exposure to science communications. The role of trust in the source of a message as a moderator of persuasion is well

established (e.g., O'Keefe 2002). When it comes to evaluating science-based arguments, those with higher levels of trust will be more likely to accept frames highlighting positive consequences and evidence because the information is seen as sponsored by a credible source (Lupia 2013). In the case of scientific evidence highlighted in a communication, it is not so much trust in scientists *per se,* but trust in the enterprise of science itself, that moderates the effect of exposure (Brewer and Ley 2013).

Hypothesis 4: Those who trust science to a greater extent will be more influenced by exposure to frames with positive consequences and scientific evidence, all else constant.

Importantly, however, we do *not* expect the trust hypothesis to carry over to exposure to politicization or negative frames; we suspect that negative information will overpower positive information and raise questions about how a specific citation to science is used despite one's general trust in science.

We also follow Arceneaux (2012) in positing anxiety as a key factor underlying the impact of the uncertainty generated by politicization on support for the status quo. Arceneaux (2012) explains: "Anxiety is an important focusing emotion. It alerts individuals to potential threats to desired outcomes… [however] when anticipating a loss is associated with activity in brain regions that trigger anxiety, people are more likely to choose strategies designed to minimize their losses…[and] are not more likely to behave in a [risk-seeking] fashion" (272–73). For reasons we note, our study is not designed to directly test mediation; we do, however, offer suggestive evidence.

Hypothesis 5: Anxiety will increase when exposed to a frame that includes politicization, all else constant.

Experiments

We test our hypotheses with two experiments that focus on support for using nuclear power in the United States. We chose nuclear energy because it is a technology with which people are familiar, and thus any treatment effects are not simply due to lack of familiarity with the subject (see Druckman and Leeper 2012a). There also are clear pro and con frames (see Ansolabehere and Konisky 2009), allowing for a test of our hypotheses and a status quo such that nearly all of the mass public is aware that no ground has been broken on new nuclear reactors in decades (precisely, since 1974). Following the partial meltdown of the Three Mile Island nuclear reactor outside Harrisburg, Pennsylvania, on March 28, 1979, public opinion shifted away from support for "building more nuclear power plants" in the United States, and that support dropped further following the meltdown at Chernobyl in July 1986 (only

24 percent supported building new plants in the United States at that time); in addition, two thirds of the public reported opposition to the construction of "more nuclear power plants" in 2005 (Bolsen and Cook 2008, 374). Thus, *the clear status quo is no new construction of nuclear power plants.* This allows us to test our hypotheses regarding how politicization can generate a status-quo bias in the face of supportive arguments and scientific evidence. We believe this would generalize to support for other scientific adaptations where the status quo is nonuse. Finally, a focus on nuclear energy was quite sensible given how at the time of our study, there were several proposals to build nuclear reactors that are still being debated (Ansolabehere and Konisky 2009; MIT 2009).[1]

EXPERIMENT 1

Our first experiment took place embedded in a survey experiment in August 2010.[2] We used the internet to draw a representative sample of 1,600 members of the U.S. population.[3] Participants completed an initial battery of attitudinal and demographic questions. Next, they were exposed to one of the treatments (described below). All participants were informed, "We are now going to ask

1. Indeed, in February 2010, the U.S. Department of Energy approved loan guarantees to aid in the construction of two nuclear reactors in Georgia and, as mentioned, if the projects go forward, they would be the first reactors approved in the United States since the early 1970s (Wald 2010).
2. Our first study took place prior to the accident in Fukushima, Japan. On March 11, 2011, an earthquake and tsunami in Japan caused significant damage to several nuclear reactors. Media coverage was extensive. Public opinion polls in the United States showed a notable decline in support for using nuclear energy. This is problematic for energy policy given the renewed commitment to nuclear energy and is relevant for us given that our data for the first study were collected prior to this event. However, we expect the accident only to affect overall support for nuclear energy and not to condition the causal impact of the experimental conditions. Indeed, we conducted a lab experiment virtually identical to our main study using a sample of undergraduate students to confirm that the *treatment effects remained unchanged after the earthquake*. Results, available upon request from the authors, show that the causal effects resulting from exposure to the experimental conditions are roughly the same but, as expected, overall support for using nuclear energy dropped by about 6 percent across conditions (see Druckman and Kam [2011] on the robustness of student subjects in experiments).
3. We contracted with a survey research company (Bovitz Inc.) to collect the data. The sample was drawn from a panel of respondents who have opted in to complete online surveys. The panel was originally developed based on a random-digit-dial (RDD) telephone survey, where to enter the panel a respondent needed to have access to the internet. (In this sense, it is a non-probability sample in the same way as those taken by firms such as YouGov are non-probability samples.) The panel has continued to grow based on ongoing RDD recruiting and referrals. From the panel, which has approximately one million members, a given sample is drawn using a matching algorithm (based on likely response rates) to ensure that those screened to qualify for the survey constitute a sample that demographically represents the United States. Of those contacted to participate in the survey, about 21 percent opted in, which is similar to other experimental approaches using opt-in surveys and in line with AAPOR guidelines and published in *Public Opinion Quarterly* (see, e.g., Bailenson et al. 2008). Moreover, for experimental studies, this sampling approach is acceptable (see Druckman and Kam 2011).

you about an alternative energy source—nuclear power." Respondents in the control condition were then presented with our primary dependent measure, which asked, "Given what you know, to what extent do you oppose or support the use of nuclear energy as one of the ways to provide electricity for the United States?" on a seven-point fully labeled scale ranging from 1 = "strongly oppose" to 7 = "strongly support."[4] This is our central dependent variable. All other participants were *randomly* assigned to one of eight other conditions that manipulated the presence and/or absence of the aforementioned three dimensions.

As shown in table 1, we included three conditions that incorporated a politicization frame (rows 6, 7, and 8). The first hypothesis suggests that, regardless of any other dimension in the frame, respondents will hold on to the status quo and oppose the construction of new nuclear power plants. For this hypothesis, comparisons are relative to the control group (see Druckman [2001a] on points of comparisons in framing experiments).

We chose an environmental consequence frame in this experiment because of its prominence in debates over nuclear power (Ansolabehere and Konisky 2009). To test hypothesis 2a (we test 2b only in study 2), we included conditions that included only the positive environmental frame (row 1). We are also interested in whether the addition of evidence enhances an argument's impact relative to an analogous condition without the evidence. Thus, to test hypothesis 3, we added a reference to *consensus* scientific evidence from a presumably trusted source; that is, the National Academy of Sciences (NAS) (row 5).[5]

We did not formally hypothesize on the other conditions that include the scientific progress frame, which we see as counter to the politicization frame (given scant theory or other work on the topic). We include this condition not only due to its interest as a counterfactual but also because it accords with the scientific literacy literature (for a discussion but also critique of this theory, see Nisbet [2007]) that emphasizing the progress of science (especially with evidence) will enhance support. Thus, we are interested if the addition of this frame generates greater support for nuclear power than the conditions that lack but otherwise share the same frames (i.e., environmental argument without, and then with, evidence). We pilot-tested all frames on student samples. Of particular note is that one separate group of 100 respondents found that the politicization frame alone generated significantly lower trust in science and decreased optimism toward science. Conversely, on a different group of 100 respondents, we found that the science progress frame generated increased trust in science and led to greater optimism toward science. We pilot-tested the environmental frame on its own on yet another distinct 100-person group, and participants found it compelling

4. The appendix reports the exact wording and order for all questions included in the study.

5. We recognize that many respondents may not realize that the job of the National Academy of Sciences as a non-profit, independent organization entails offering consensus advice on science, technology, and medicine, based on expert panels. Thus, any effect could stem from a full understanding that the National Academy does provide consensus evidence, or it could be simply seen as a credible source cue.

Table 1. Experiment 1 Conditions and Wording

Condition	Wording
Environment alone	We are now going to ask you about an alternative energy source—nuclear power. Many have pointed to research that suggests alternative energy sources (e.g., nuclear energy) can dramatically improve the environment, relative to fossil fuels like coal and oil that release greenhouse gases and cause pollution. For example, unlike fossil fuels, wastes from nuclear energy are not released into the environment.
Environment with evidence	We are now going to ask you about an alternative energy source—nuclear power. Many have pointed to research that suggests alternative energy sources (e.g., nuclear energy) can dramatically improve the environment, relative to fossil fuels like coal and oil that release greenhouse gases and cause pollution. For example, unlike fossil fuels, wastes from nuclear energy are not released into the environment. A recent National Academy of Sciences publication states: "A general scientific and technical consensus exists that deep geologic disposal can provide predictable and effective long-term isolation of nuclear wastes."
Scientific progress alone	We are now going to ask you about an alternative energy source—nuclear power. The development of alternative energies, such as nuclear energy, relies on scientific progress. Indeed, scientific research involves the systematic gathering of observable, measurable, and replicable evidence—as such, it provides a relatively objective and unbiased basis for new innovations.
Science with environment	We are now going to ask you about an alternative energy source—nuclear power. The development of alternative energies, such as nuclear energy, relies on scientific progress. Indeed, scientific research involves the systematic gathering of observable, measurable, and replicable evidence—as such, it provides a relatively objective and unbiased basis for new innovations. Along these lines, many have pointed to research that suggests alternative energy sources (e.g., nuclear energy) can dramatically improve the environment, relative to fossil fuels like coal and oil that release greenhouse gases and cause pollution. For example, unlike fossil fuels, wastes from nuclear energy are not released into the environment.

(*Continued*)

Table 1. *Continued*

Condition	Wording
Science, environment, and evidence	We are now going to ask you about an alternative energy source—nuclear power. The development of alternative energies, such as nuclear energy, relies on scientific progress. Indeed, scientific research involves the systematic gathering of observable, measurable, and replicable evidence—as such, it provides a relatively objective and unbiased basis for new innovations. Along these lines, many have pointed to research that suggests alternative energy sources (e.g., nuclear energy) can dramatically improve the environment, relative to fossil fuels like coal and oil that release greenhouse gases and cause pollution. For example, unlike fossil fuels, wastes from nuclear energy are not released into the environment. A recent National Academy of Sciences publication states: "A general scientific and technical consensus exists that deep geologic disposal can provide predictable and effective long-term isolation of nuclear wastes."
Politicization alone	We are now going to ask you about an alternative energy source—nuclear power. The development of alternative energies, such as nuclear energy, relies on scientific progress. Yet, it is increasingly difficult for non-experts to evaluate science—politicians and others often color scientific work and advocate selective science to favor their agendas.
Politicization with environment	We are now going to ask you about an alternative energy source—nuclear power. The development of alternative energies, such as nuclear energy, relies on scientific progress. Yet, it is increasingly difficult for non-experts to evaluate science—politicians and others often color scientific work and advocate selective science to favor their agendas. Even so, many have pointed to research that suggests alternative energy sources (e.g., nuclear energy) can dramatically improve the environment, relative to fossil fuels like coal and oil that release greenhouse gases and cause pollution. For example, unlike fossil fuels, wastes from nuclear energy are not released into the environment.

(*Continued*)

Table 1. *Continued*

Condition	Wording
Politicization, environment with evidence	We are now going to ask you about an alternative energy source—nuclear power. The development of alternative energies, such as nuclear energy, relies on scientific progress. Yet, it is increasingly difficult for non-experts to evaluate science—politicians and others often color scientific work and advocate selective science to favor their agendas. Even so, many have pointed to research that suggests alternative energy sources (e.g., nuclear energy) can dramatically improve the environment, relative to fossil fuels like coal and oil that release greenhouse gases and cause pollution. For example, unlike fossil fuels, wastes from nuclear energy are not released into the environment. A recent National Academy of Sciences publication states: "A general scientific and technical consensus exists that deep geologic disposal can provide predictable and effective long-term isolation of nuclear wastes."

(i.e., strong) (on a seven-point scale, with 7 being "very effective," M = 4.9; std. dev. = .10). We recognize that the length of our manipulations vary; however, longer arguments tend to be more persuasive (O'Keefe 2002), and this would be counter to at least some of our hypotheses (e.g., hypothesis 1).

Results

We explore how each experimental condition affects support for using nuclear power to generate electricity in the United States, first and most clearly relative to our control-group baseline. Figure 1 displays the percentage movement from the control group, as well as the mean, standard deviation, and *N* for each condition (below each bar).[6] For example, the mean support for nuclear power for participants randomly assigned to the control group is 4.46 (std. dev. = 1.78; *N* = 178) (across conditions, the mean support for nuclear power is 4.56; std. dev. = 1.86; *N* = 1,600). These results indicate that our random assignment was successful, and in the online appendix we present analyses that show the robustness of all main treatment effects reported below, with the inclusion of a host of control variables.[7]

6. As a manipulation check, we asked participants, "To what extent do you think political considerations affect the nature of information the public receives about different policies?" on a seven-point fully labeled scale ranging from 1 = "not at all" to 7 = "always." Participants randomly assigned to the politicization conditions reported significantly higher scores on this question.

7. We use one-tailed tests of significance, as is common in the framing literature, given that we have clear theoretical expectations for the impact of our experimental conditions on opinions (Blalock 1979).

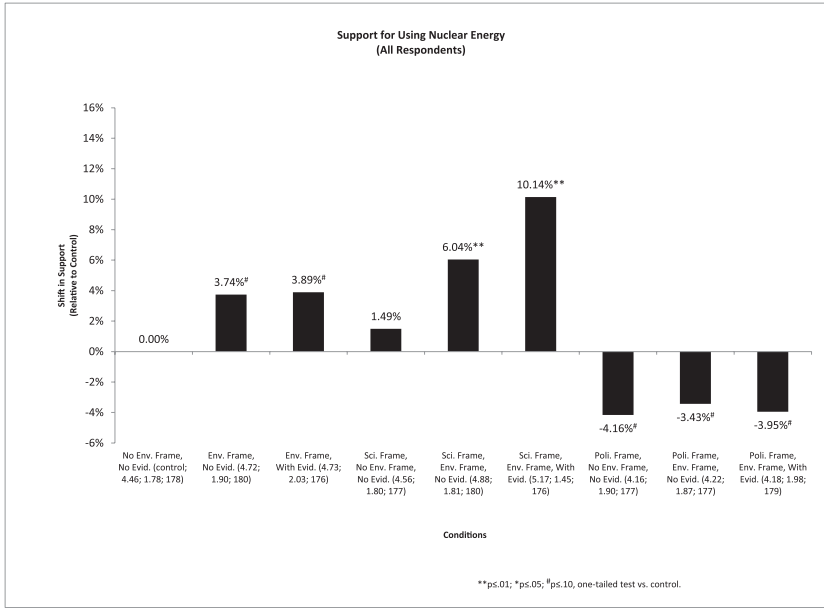

Figure 1. Support for Using Nuclear Energy (all respondents).

First, we find strong support for hypothesis 1. *Regardless* of what other dimensions are included (none, environmental frame only, or environmental frame with evidence), exposure to a frame highlighting that science is often politicized causes individuals to hold on to the status quo and oppose the expansion of nuclear energy. This is, in some senses, a stunning finding and resonates with the aforementioned concern expressed in *Nature*—that is, simply highlighting politicization generates a significant decrease in support for the use of nuclear energy. While one may debate whether nuclear energy is good or bad, it is clear that the effect stems directly from exposure to a frame that highlights the politicization of science.

When it comes to hypothesis 2a—that exposure to the positive environmental frame should generate increased support for nuclear energy—we find clear support insofar as exposure to that frame increases support. Namely, support in this instance is 3.74 percent over the control group compared to 3.89 when joined with the scientific evidence frame.

The evidence in support of hypothesis 3 is mixed. When evidence is added to the environmental frame, we see almost no change in support for nuclear energy: the relative increase of 3.89 percent over the control group is nowhere near significantly larger than the 3.74 percent increase without the evidence. Yet, when the promise-of-science frame appears in conjunction with the environmental frame, we see a significant increase in support from adding the evidence to the frame—an increase in support from 6.04 to 10.14 percent.

We did not have a formal hypothesis regarding the impact of exposure to the scientific progress frame by itself. However, when this frame stands alone, it has no impact (a nonsignificant 1.49 percent increase relative to the control group), and only seems to matter when it appears in conjunction with the aforementioned environmental frame with or without evidence. The increase in the support for the environmental frame with evidence (3.89 percent) is not significantly different from the increase for a frame that includes both support with evidence and the benefits of science (6.04 percent).

In sum, our first study offers clear evidence that frames that highlight the politicization of science, even when joined with a supportive environmental frame and consensus scientific evidence, result in a status-quo bias and significantly greater opposition to the expansion of nuclear power. While the effect sizes may appear small (e.g., up to around .75 on a seven-point scale), they are actually in line with, or in many cases much larger compared to, prior framing studies (e.g., Nelson, Oxley, and Clawson 1997; Druckman and Nelson 2003; Chong and Druckman 2007). Moreover, the size of these effects may be seen as particularly stark given that many prior framing experiments focus on issues on which individuals likely have very weak or no prior opinions (see Druckman and Leeper [2012a] for a discussion). In our study, we can assume that everyone came in with some available considerations about nuclear energy, and thus the pre-treatment dynamic may depress actual effects (see Druckman and Leeper 2012b). Finally, one might consider these differences to be substantial in light of the fact that the treatments consisted of exposure to a single communication, when in reality these messages may be repeated and lead to much larger effects (Druckman, Fein, and Leeper 2012). In short, the impact of exposure to the politicization frame is far from substantively unimportant. The key result is that simply mentioning that science is politicized can undermine support for scientific adaptations.[8]

As mentioned, our results are robust to including a host of controls, but as the appendix shows, by far the most impactful control variable is trust in science—a variable we expected to moderate our treatment effects. We now turn to testing this hypothesis.

MODERATOR AND MEDIATION RESULTS

We replicate figure 1 for those with higher levels of trust in science (see figure 2) and those with lower levels of trust in science (see figure 3) to test hypothesis 4. We hypothesize stronger effects among those with higher levels of trust in science because they will be more likely to find arguments related

8. We also asked a series of belief-importance questions (e.g., in thinking about nuclear energy, how important are the effects of nuclear energy on the environment or human health?), and belief-content questions that asked whether nuclear energy would have positive or negative effects on these dimensions. As expected, given the large literature on framing effects, our results largely replicate what is presented in figure 1.

to science and evidence supported by a consensus of scientists persuasive. We used a conventional measure of trust in science (Beveridge and Rudell 1988; Bauer, Allen, and Miller 2007) that asks, "Do you think that science enables us to overcome almost any problem or that science creates unintended consequences and replaces older problems with new ones?" with responses ranging from 1 = "definitely overcomes problems" to 7 = "definitely creates new problems."[9]

The results for high trusters in figure 2 and low trusters in figure 3 provide strong support for hypothesis 4. Those who trust science were influenced by the frames following the same pattern as shown in figure 1, albeit with larger effects. Individuals who have high levels of preexisting trust in science do not need to be reminded about the benefits of science for the environmental frame with or without evidence to have quite large effects (7.56 and 7.79 percent increase in support, respectively), although reminding them increases the impact of the frames (9.63 and 15.17 percent increase in support, respectively).

Interestingly, as speculated, frames that highlight politicization, even among those who trust science a great deal, wiped out support for nuclear energy even when joined with an argument about the environmental benefits with or without evidence, thereby accentuating how reminding people about the selective use of science can generate a status-quo bias even among people who generally trust science (i.e., they presumably then are reminded that they may not know what science to trust). In short, politicization can vitiate support for an adaptation because it causes people—even those who possess high levels of trust in science—to be uncertain about what they can and cannot believe in any specific instance.

On the flip side, individuals reporting lower levels of trust in science increase support for nuclear power only when provided with a scientific progress frame, an environmental benefits frame, and consensus scientific evidence. Even in this case, however, the increase (6.93 percent) is still significantly less than that found among those with higher levels of trust in science (15.17 percent) ($t_{171} = 3.87$; $p \leq .01$).[10] Otherwise, the frames had no significant effect or, in the case of politicization, significantly decreased support.

We measured anxiety with a conventional approach (e.g., Marcus, Neuman, and MacKuen 2000) by asking, "As you think about using nuclear energy, how

9. Like other work (e.g., Nelson, Oxley, and Clawson 1997: Gauchat 2012), we use a median split to minimize measurement error. Indeed, we expect that the measures contain error such that slight changes on the respective scales may not accurately capture real differences. In contrast, a median split allows us to focus on what are more likely to be qualitatively distinct groups. Note, however, that the differences between groups are significant when we estimate the treatment effects with a model that includes interactions between each experimental condition and our trust measure. Further, we confirmed that all of the main treatment effects are robust with multivariate analyses using the same control variables; see the online appendix (supplementary data online).

10. We assume that nonsignificant changes are akin to 0 shift and thus do not perform other *t*-tests.

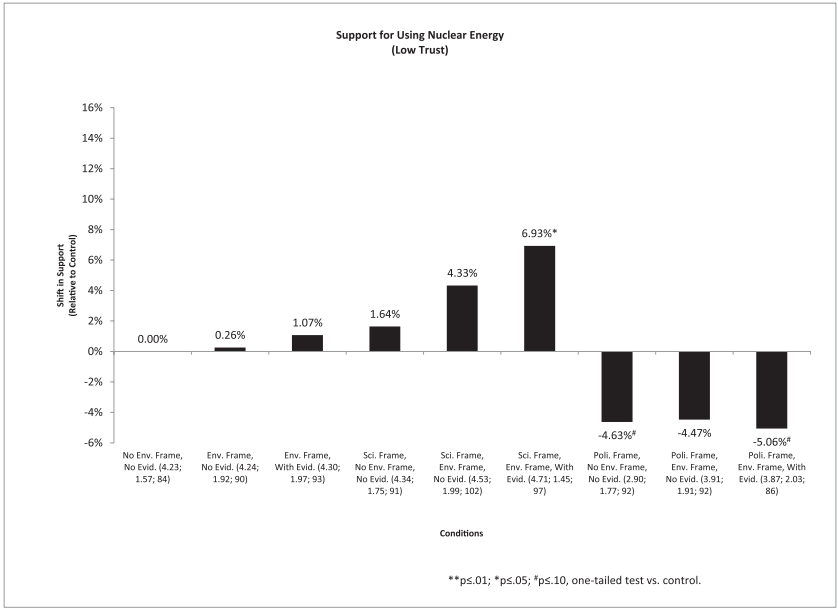

Figure 2. Support for Using Nuclear Energy (low trust).

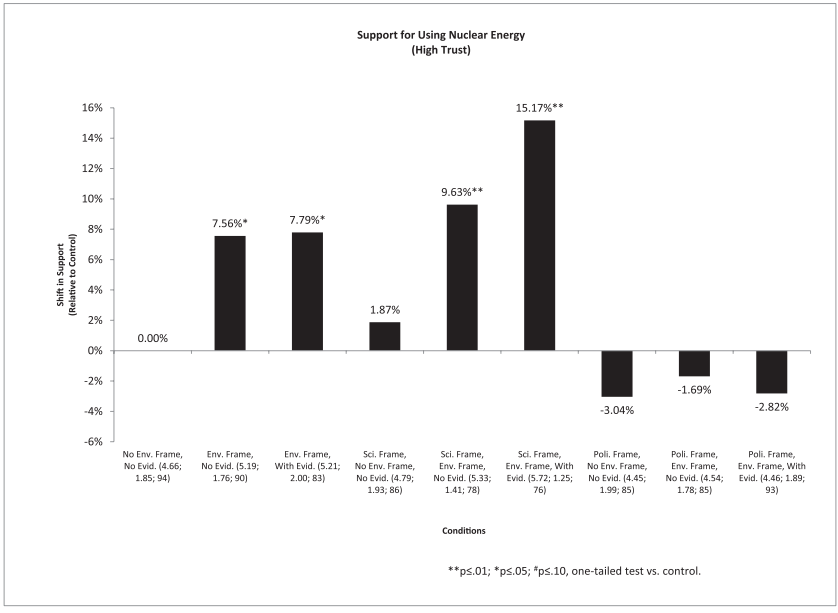

Figure 3. Support for Using Nuclear Energy (high trust).

much anxiety do you feel?" on a five-point scale ranging from 1 = "none at all" to 5 = " a great deal." We regressed our anxiety measure on each experiment condition to test hypothesis 5, that anxiety will increase as a result of exposure to politicization and mediate the impact of uncertainty on opinions (see column 2, table 2).

The results strongly support hypothesis 5. The first column of table 2 merely replicates the results presented in figure 1, showing which conditions significantly move support. It is the second column that clearly shows that each frame containing politicization—even when presented by itself—increases anxiety about using nuclear energy. Moreover, although we did not predict it, not surprisingly, two of the three frames that highlight the progress of science (i.e., the ones that also include the environmental frame with and without evidence) significantly decrease anxiety about using nuclear energy. This makes sense given our speculation that exposure to a frame highlighting the progress of science may decrease uncertainty toward a scientific adaptation, thereby vitiating anxiety.

Our study was not designed to test for mediation *per se* (see Bullock and Ha [2011] for a discussion); nonetheless, Arceneaux (2012) suggests—and it is sensible that—anxiety may mediate the main effect of exposure to the politicization frame on decreased support for nuclear energy. We offer suggestive evidence along these lines in the right-hand column of table 2, where the Baron-Kenny technique (Baron and Kenny 1986; Kenny 2008) shows what happens when the model also includes the anxiety measure, which we showed was influenced by politicization in the second model. Results show that while its inclusion in the model has virtually no impact on how other frames shape support for using nuclear power, anxiety reduces to nonsignificance the coefficients in all politicization conditions, suggesting that it mediates exposure to frames that politicize science.

While it is possible to generate increased support for nuclear power when one includes a supportive argument and a reference to evidence supported by a consensus of scientists, simply calling attention to the politicization of science mutes any support generated by exposure to this information and, in general, significantly decreases support. While one can argue for or against any given technology, the more relevant point is that even for a technology that scientists and/or others may see as promising, politicization can have a substantial influence on its implementation.

EXPERIMENT 2

One constraint in experiment 1 is that we employed only a positive consequence frame (i.e., a frame emphasizing the environmental benefits of nuclear energy), when the reality is that negative frames also enter the picture on this issue. This precluded testing hypothesis 2b, which posits that exposure to a negative frame will cause individuals to decrease support even in light of a frame highlighting

Table 2. Experiment 1: Ordered Probit Coefficients for Determinants of Support for Nuclear Power and Anxiety (standard errors in parentheses)

	Support for using nuclear energy (model 1) *N = 1,600*		Anxiety (model 2) *N = 1,600*		Support for using nuclear energy (model 3) *N = 1,600*	
Independent variables:	*Coef.*	*Std. error*	*Coef.*	*Std. error*	*Coef.*	*Std. error*
Environmental frame without evidence (*condition 2*)	.16*	(.11)	–.04	(.11)	.15*	(.11)
Environmental frame with evidence (*condition 3*)	.17*	(.11)	–.02	(.11)	.18*	(.11)
Science frame *(condition 4)*	.06	(.11)	.05	(.11)	.08	(.49)
Science frame and environmental frame without evidence (*condition 5*)	.24**	(.11)	–.16*	(.11)	.20**	(.11)
Science frame and environmental frame with evidence (*condition 6*)	.40***	(.11)	–.18**	(.11)	.36***	(.11)
Politicization frame (*condition 7*)	–.14*	(.11)	.20**	(.11)	–.07	(.11)
Politicization frame + environmental frame without evidence (*condition 8*)	–.14*	(.11)	.49***	(.11)	–.004	(.11)
Politicization frame + environmental frame with evidence (*condition 9*)	–.15*	(.11)	.34***	(.11)	–.06	(.11)
Anxiety	–		–		–.98***	(.08)
Cut points:	See below		See below		See below	
Log-likelihood	–2,991.26		–2,521.60		–2,917.34	

NOTE.—The columns contain ordered probit coefficient estimates predicting experimental treatment effects relative to the control (baseline) condition. ***$p \leq .01$; **$p \leq .05$; *$p \leq .10$ (one-tailed tests). The coefficients and standard errors for cut points 1 through 6 for model 1 are –1.29 (0.09), –0.94 (0.08), –0.56 (0.08), –0.002 (0.08), 0.42 (0.08), and 0.96 (0.08). The coefficients and standard errors for cut points 1 through 4 for model 2 are –83 (0.08), –.06 (.08), .48 (.08), and 1.05 (.08). The coefficients and standard errors for cut points 1 through 6 for model 3 are –1.79 (.10), –1.42 (.09), –1.02 (.09), –.44 (.09), –.001 (.09), and .57 (.09). In model 1 and model 3, 1 = "strongly oppose" and 7 = "strongly support." In model 2, 1 = "none at all" and 7 = "a great deal."

the politicization of science (due to the aforementioned negativity bias). Thus, we implemented a smaller-scale experiment to test this hypothesis.

Specifically, we implemented an experiment with a design analogous to our main study, with one key difference: We used a negative frame emphasizing the potential health hazards of using nuclear energy, and evidence of such health hazards from another NAS (2008) report (Board on Radiation Effects Research 2006). The experiment contained fewer conditions, as listed in table 3 along with the wording for each treatment. We limited this study to five conditions, including the baseline control, scientific progress frame with the negative health frame, science benefit frame with the negative health frame and evidence, a politicization frame joined with the negative health frame, and a politicization frame with the negative health frame and evidence. This ensured a sufficient sample size and allowed us to not only see if politicization has analogous effects even when the frame/evidence is negative, but also to explore the direct impact of a negative health frame even when paired with a scientific progress frame.

The study itself was part of an exit poll on Election Day 2010, in which a team of 25 pollsters handed out anonymous self-administered surveys to voters departing the polling stations at random voting locations throughout Illinois's 9th Congressional District. Pollsters offered respondents a $5 gift card as compensation for filling out a survey on political opinions for an academic research project. Participants were randomly assigned to one of the five conditions listed in table 3. Each survey was randomized across polling sites to ensure that the conditions were not correlated with the polling locations. In total, 707 individuals completed the survey at a response rate of 70 percent; we arrived at 70 percent because of those approached, 70 percent complied and completed the survey.

The results displayed in figure 4 provide strong support for hypothesis 2b. In the presence of a negative frame regarding the negative health implications from using nuclear energy, there is a significant decrease in support for using nuclear energy, even when science's progress is emphasized. This finding is in line with many others who highlight the overweighting of negative information in competitive information contexts.[11] More interestingly, when the negative health frame with or without evidence is presented in conjunction with a frame highlighting the politicization of science, the negative health frame overpowers the politicization frame and leads to greater opposition for using nuclear power. That is, people appear to trust the negative health frame and do not discount it as with the positive frame and evidence in experiment 1. Of course, more work is needed to determine the underlying mechanism driving the results.

Conclusion

The politicization of science has received a great deal of attention in recent years. We are the first to directly explore how frames that highlight

11. We also measured anxiety and find that all conditions increase anxiety.

Table 3. Experiment 2 Conditions and Wording

Condition	Wording
Scientific progress with health	We are now going to ask you about an alternative energy source—nuclear power. Many argue that increased usage of nuclear power can lessen our dependence on polluting fossil fuels. In general, the development of alternative energy sources, such as nuclear energy, relies on scientific progress. Scientific research involves the systematic gathering of observable, measureable, and replicable evidence—as such, it provides a relatively objective and unbiased basis for new innovations. Such scientific research suggests that alternative energy sources can sometimes raise health concerns.
Scientific progress, health, and evidence	We are now going to ask you about an alternative energy source—nuclear power. Many argue that increased usage of nuclear power can lessen our dependence on polluting fossil fuels. In general, the development of alternative energy sources, such as nuclear energy, relies on scientific progress. Scientific research involves the systematic gathering of observable, measureable, and replicable evidence—as such, it provides a relatively objective and unbiased basis for new innovations. Such scientific research suggests that alternative energy sources can sometimes raise health concerns. A recent National Academy of Sciences report states: "the risk of cancer proceeds in a linear fashion…and the smallest dose has the potential to cause an increase in risk to humans."

(*Continued*)

politicization affect public support for scientific adaptations. We find that politicizing science reduces support for nuclear power and renders arguments about the environmental benefits of nuclear energy invalid, regardless of whether there is a reference to consensus scientific evidence. We also find that a reference to the potential health risks associated with using nuclear power also decreases support in the presence of additional frames that highlight either science's progress or its politicization (i.e., a probable negativity bias).

Table 3. *Continued*

Condition	Wording
Politicization with health	We are now going to ask you about an alternative energy source—nuclear power. Many argue that increased usage of nuclear power can lessen our dependence on polluting fossil fuels. In general, the development of alternative energy sources, such as nuclear energy, relies on scientific progress. It is increasingly difficult, however, for non-experts to evaluate science—politics often colors scientific work and advocates selectively use science to favor their agendas. That said, scientific research suggests that alternative energy sources can sometimes raise health concerns.
Politicization, health, and evidence	We are now going to ask you about an alternative energy source—nuclear power. Many argue that increased usage of nuclear power can lessen our dependence on polluting fossil fuels. In general, the development of alternative energy sources, such as nuclear energy, relies on scientific progress. It is increasingly difficult, however, for non-experts to evaluate science—politics often colors scientific work and advocates selectively use science to favor their agendas. That said, scientific research suggests that alternative energy sources can sometimes raise health concerns. A recent National Academy of Sciences report states: "the risk of cancer proceeds in a linear fashion…and the smallest dose has the potential to cause an increase in risk to humans."

One brief question is how long these effects persist, even when exposed to a politicization-of-science frame only once. Briefly, we conducted a follow-up to our first study, two weeks after the original survey, and found that on a *distinct technology* (in this case, nanotechnology), those randomly assigned to the politicization conditions in the first survey administered two weeks earlier registered significantly lower support for its use relative to a control group. This is an intriguing result, as it suggests the possibility of motivated reasoning whereby exposure to politicization drives future evaluations toward other scientific adaptations.

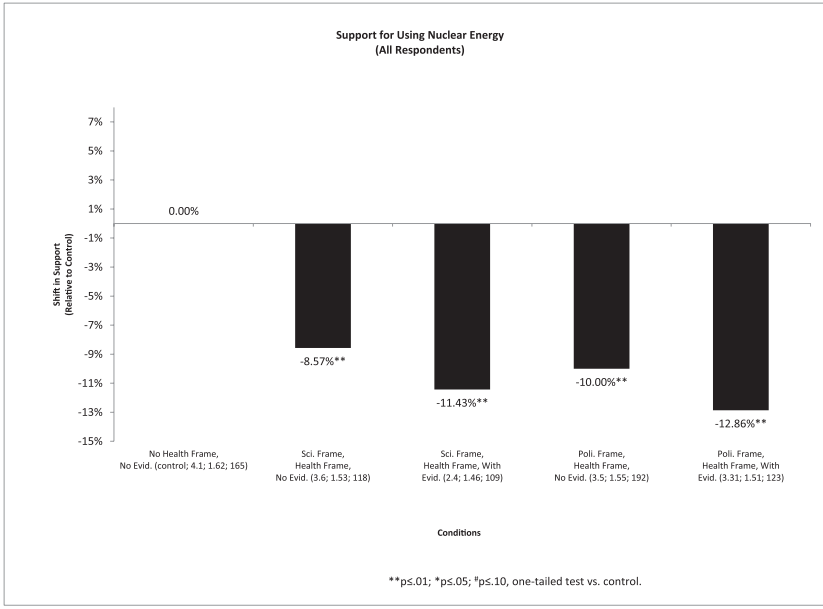

Figure 4. Support for Using Nuclear Energy (all respondents).

We recognize that this is one of many directions for future research. We view two as particularly critical. First, as is clear, we operationalized politicization as a "frame," where we simply remind people that science is often politicized. Yet, in many cases, politicization does not work that way, but reflects "politicization in action," where advocates on each side of a debate selectively point to different "scientific" studies. It is not clear, in this case, that our results would be replicated. This is especially true when sources are attached to the distinct arguments. Moreover, given the prevalence of motivated reasoning, people accept evidence from sources with whom they share an outlook and dismiss it from sources with whom they disagree. It could be that individuals simply follow the opinion associated with the sources they trust the most regardless of the "scientific merit" of the frames sponsored by the source (see Lodge and Taber 2013).

A second key question concerns what can be done if politicization does indeed impede progress in cases where it would be beneficial to society. This is a challenging question (see Lupia 2013), in large part because of the well-known status-quo bias for which no one, to the best of our knowledge, has discovered a consistent way of overcoming. The same can be said of the negativity bias. That is, citizens seem risk averse to change, and how to overcome this for scientists, policymakers, and citizens is not entirely clear. Future work needs to explore better ways to communicate science, perhaps by developing methods for validating science and engaging scientists and the public to a greater extent in the communication process itself, and

byincreasing collaboration between scientists and communication scholars on what frames and information may work best.

In the end, our findings highlight the seriousness of politicization as a hurdle to moving forward with new areas of science. This is something that also could carry over to areas beyond technologies, such as health, immigration, and other political/social issues. When politics prevents the adoption of scientific adaptations that would benefit most people, there are few higher priorities than finding ways to intercede in that political process.

Appendix. Survey Questionnaire

Given what you know, to what extent do you oppose or support the use of nuclear energy as one of the ways to provide electricity for the United States?

strongly oppose	*moderately oppose*	*slightly oppose*	*neither oppose nor support*	*slightly support*	*moderately support*	*strongly support*

When thinking about whether you oppose or support the use of nuclear energy, how important to you are the effects of nuclear energy on sustaining the environment?

extremely unimportant	*very unimportant*	*somewhat unimportant*	*neither unimportant nor important*	*somewhat important*	*very important*	*extremely important*

When thinking about whether you oppose or support the use of nuclear energy, how important to you are the effects of nuclear energy on human health?

extremely unimportant	*very unimportant*	*somewhat unimportant*	*neither unimportant nor important*	*somewhat important*	*very important*	*extremely important*

Do you think the use of nuclear energy will have negative or positive consequences for sustaining the environment?

definitely negative	*very likely negative*	*likely negative*	*neither negative nor positive*	*likely positive*	*very likely positive*	*definitely positive*

Do you think the use of nuclear energy will have negative or positive consequences for human health?

definitely negative	*very likely negative*	*likely negative*	*neither negative nor positive*	*likely positive*	*very likely positive*	*definitely positive*

As you think about using nuclear energy, how much anxiety do you feel?

none at all	*a little*	*a moderate amount*	*a good amount*	*a great deal*

To what extent do you think political considerations affect the nature of the information that the public receives about different policies?

not at all	*not very much*	*a little*	*a moderate amount*	*a good amount*	*a great deal*	*always*

Supplementary Data

Supplementary data are freely available online at http://poq.oxfordjournals.org/.

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