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Technical issues and engagement processes: support for citizen and expert deliberation regarding the management of nuclear waste

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Deliberative forums have been increasingly used to involve citizens in policymaking, but it is unclear whether people trust their fellow citizens to make decisions in highly technical areas like nuclear policy relative to more commonly used expert bodies. We examine public support for citizen and expert deliberation regarding the siting of nuclear waste facilities and note the role of values, views on deliberation, and civic experiences on support for each type of deliberation. We find that past civic experiences are associated with increased support for citizen decision-making. In addition, we find that underlying views on nuclear power may be more important in shaping support for a decision on nuclear waste facility siting than attitudes toward particular kinds of governance processes.

KEYWORDS

deliberation, nuclear communication, public engagement, environmental governance, public participation

Introduction

As faith in political leaders and institutions has waned and citizens have felt less able to effect change in public policy, some government entities have turned to participatory forms of governance to help engage community members and rebuild trust (Fung and Wright, 2001; Leighninger, 2013). Deliberative forums and similar methods have been used in a wide range of domains and contexts in recent years and have seen much success in getting citizens and stakeholders involved in the policymaking process, even on scientific and technical topics (Pallett, 2015; Dempster et al., 2019). However, some policy questions related to energy use and the environment, such as nuclear power and waste storage, are highly technical in nature and may be challenging for lay citizens to discuss. In addition, such technical domains are often governed in technocratic ways by policy and technological experts (Blue Ribbon Commission, 2012), leaving some citizens to struggle with expressing their concerns about policy decisions (Endres, 2009). As a result, there is a well-documented gap between the low level of public participation that many political leaders think citizens are capable of and the much higher level of participation that affected citizens actually want in nuclear energy policymaking (Hamilton, 2004, 2007).

Though there has been some success in using participatory and deliberative methods in the nuclear domain (Hamilton, 2004; Maxwell et al., 2004; Carson, 2017), and a recognition by authorities that nuclear policy must include citizen input (Blue Ribbon Commission, 2012; Department of Energy, 2023), there is still much to learn about what factors would affect participation in such public forums, as well as how much people trust their fellow citizens to make decisions on nuclear policy compared to experts (Berdahl et al., 2016). In addition, people seem open to letting go of their ideological pre-conceptions and receiving guidance from their citizens via deliberative mini-publics when deciding on policy questions (Gastil et al., 2014, 2016), but it is less clear whether the broader public will support a deliberative citizen panel making a policy decision itself. How well, then, does the public trust that nuclear policy decisions can be made by their fellow citizens vs. a panel of experts, and how do they view the legitimacy of those decisions? Further, how well does a recommendation from a deliberative mini-public help people move beyond their ideological biases in evaluating policy?

In this paper, we set out to answer these questions in the context of the governance of nuclear power and waste storage. We first review relevant literature on deliberation and public forums; public opinion and engagement on nuclear power; and the value of deliberative cues in helping citizens reach decisions on political issues. We then analyze data from a national survey on energy and environmental issues to examine how civic experiences, general preferences for citizen deliberation, cultural worldview, and some common demographic characteristics affect support for using citizen deliberative panels and expert panels to make siting decisions for nuclear waste storage facilities, as well as what affects support for a decision made by either a citizen or an expert panel to site a facility in a community. We note that support for a citizen panel process is driven by general support for deliberative panels and experience with a trial jury, rather than traditional predictors of political participation. Values and worldview, however, are associated with support for an expert panel process. Support for a decision made by either a citizen or expert panel is correlated with a wide range of factors. The complex differences suggest that support for a decision is driven by a diverse set of factors that may impact the perception of process outcomes for many individuals and that underlying views on the issue of nuclear energy may be more important than process-related views. We also discuss the implications of these findings for the legitimacy of nuclear policy processes with respect to citizen involvement, and what these suggest for how policymakers should try to engage with the public moving forward.

Public deliberation

For many citizens, one of the main forms of participation that lets them influence government agency decision-making is providing comments on a decision in open comment periods for government entities. This form of public engagement often leaves those participating feeling dissatisfied because of a lack of meaningful dialogue between decision-makers and the larger public, especially in engagement processes on highly technical issues like nuclear energy and waste in which expert input is given priority (Kinsella, 2004; Dalton, 2017). Participants can feel like their input into standard public comment style events does not lead to meaningful change in policy (Bingham et al., 2005; Kelshaw and Gastil, 2007). Voting and campaigning are also formal means of influencing different forms of policy, and participation in these forums can be influenced by a variety of factors ranging from socioeconomic status to perceptions of gerrymandering (Hill and Kousser, 2016). But much like with open comment periods, the perception of voting as an inconsequential behavior for influencing policy remains persistent (Achen and Bartels, 2017).

Deliberative democracy, which involves a diverse pool of citizens engaging in thoughtful analysis and respectful discussion of a political topic, offers a robust alternative to such thin forms of citizen involvement (Gastil, 2008). Individuals experience active participation in a government decision, whether making a recommendation or learning more about a given topic through interaction with fellow citizens. Deliberation generally aims to engage a diverse cross-section of the public to ensure that participants are exposed to a wide range of views during a forum, as opposed to the self-selection and socioeconomic barriers to participation that plague many other forms of political involvement (Gastil, 2008).

Deliberative processes teach individuals how to engage in political discussion in a respectful environment, giving them the practice to engage with others after the process has concluded (Carcasson and Sprain, 2016). Participating in a constructive political event, like a citizen deliberative forum, seems to encourage individuals to support that style of participation in the future (Knobloch and Gastil, 2015), particularly when a process is perceived as robust and distinct from other forms of political participation (Neblo et al., 2010; Esterling et al., 2011). Trial juries have been successfully accomplishing this in the United States for nearly as long as the country has existed (Levine et al., 2005). Faith in the jury system is well grounded: those who participate in juries come to understand the rigor and considerations taken to ensure that the process is just (Lafont, 2015). That success leads people to have faith in the system and support its adoption in future applications, as well as to generally have greater trust in civil society and political processes (Gastil et al., 2010).

As deliberative mini-publics, some of which were expressly designed as adaptations of trial juries, are increasingly being used in applications outside of the court system, others who see its use are supporting the adoption of deliberation frameworks on public participation. A fair and successful use of deliberative forums like these can lead to lasting impacts for participants and the wider public (Knobloch and Gastil, 2015; Knobloch et al., 2020). An additional important outcome from deliberative forums is that individuals walk away with new-found support for civic engagement more broadly. Whereas others have lamented the loss of civic life in the United States (Putnam, 2001), deliberation has offered an alternative that encourages more people to get involved. Deliberation has limited effects on traditional markers of involvement in formal political life, such as campaigning for a candidate, but it does provide encouragement for individuals to become more active in their community through activities like volunteering (Knobloch and Gastil, 2015). What is interesting is that these results are not simply a replication of the process but an extension of positive interaction over difficult issues with

dissimilar others. It is because the process forces interaction with a diverse group of stakeholders who are encouraged to engage in the process in a neutral way that individuals see the merit in engaging with others and that positive outcomes are a result. Application of deliberative models in two different countries has found that participants in a deliberative process, even those who only engaged online, had increases in civic participation because of their time spent in deliberation (Rinke et al., 2013). Learning about the process and seeing it unfold, even through a mediated channel, still provides positive outcomes for participants—and recent scholarship has found ripple effects in political efficacy for citizens who were not direct participants, as well (Knobloch et al., 2020). Another potential outcome of deliberation, which we will cover in more detail below, is the influence of deliberative panel recommendations on the broader public (Gastil et al., 2018).

The issues that deliberation attempts to tackle are usually complex and value laden. If they were simple issues, decision-makers could probably make the decision without the need for public involvement. Deliberation has been used in a wide variety of topics ranging from national constitutional reformations to examinations of immigration policy (Bingham et al., 2005). One issue that has recently gained a larger share of attention is the storage of spent nuclear fuel in part because of the need for local government and community approval of bearing the risks of holding these materials. The larger historical context of nuclear energy and weapons has also contributed to the complexities of beliefs surrounding nuclear energy and its byproducts (Jenkins-Smith et al., 2011).

Public opinion and engagement on nuclear issues

Major projects involving spent nuclear fuel in the United States and many other countries have been controversial, and many long-term storage projects have been rejected (Ramana, 2018). In lieu of long-term storage, facilities rely on temporary storage at existing nuclear power sites, or on interim storage, which is often designed to hold the waste for 50–100 years until a long-term repository is built. Limited interim storage space requires new interim sites or expansion of existing sites—an issue that experts and policymakers have agreed must involve community input (Blue Ribbon Commission, 2012). Long-term repository projects have been proposed regularly, with Yucca Mountain in the U.S. being one of the highest-profile examples in the struggle to establish a permanent solution. The failure of the Yucca Mountain nuclear repository, which occurred in part because of a lack of local consent, highlights the importance of bringing together stakeholders to be educated before making a decision (Blue Ribbon Commission, 2012). Though the Department of Energy paused many of its stakeholder and citizen involvement efforts during the Trump administration, it has since revisited this topic and is moving forward with research and practical efforts on consent-based nuclear facility siting (Department of Energy, 2023).

Public opinion on nuclear power and waste storage is a complex and deeply controversial topic in the U.S., though one that is not necessarily as neatly divided along partisan lines or left-right ideologies as other issues. Perceived risks and benefits of nuclear power and views on the attendant issue of the storage of spent fuel and waste in some cases are linked to proximity to facilities and the process of regulatory approval of those facilities, among a range of other factors (Jenkins-Smith et al., 2011). Citizens' underlying values and views of the world, such as cultural worldviews like hierarchy and egalitarianism, seem to be especially important in their opinions on nuclear power and waste storage, much as with other risk-related issues like guns, climate change, vaccines, and nanotechnology (Kahan et al., 2009, 2010, 2011; Gastil et al., 2011; Jenkins-Smith et al., 2011; Trousset et al., 2015).

The values and worldviews associated with cultural theory are derived from idealized social relationships across two dimensions, a grid dimension that involves degrees of social control and a group dimension that involves the importance of group attachments (Thompson et al., 1990). Individuals higher on the grid dimension value social rules and roles that are hierarchical and clearly delineated compared to those lower on the grid dimension. Those higher on the group dimension value social solidarity more than those lower on the group dimension. Combining the grid and group dimensions creates four cultural worldviews including hierarchy (high grid, high group), egalitarianism (low grid, high group), individualism (low grid, low group), and fatalism (high grid, low group).

As noted, cultural worldviews are associated with views across a host of technical and risk-related issues (Johnson and Swedlow, 2021). Regarding nuclear energy and waste management, hierarchs and individualists are generally supportive, whereas egalitarians are generally opposed (Jones, 2011; van de Graaff, 2016). However, the group-oriented cultural types, hierarchs and egalitarians, report being more likely to participate in the siting process than the other cultural types (Trousset et al., 2015). Even as egalitarians generally oppose nuclear energy, their willingness to participate in engagement processes may make them more likely to support pro-nuclear positions if they are a result of deliberative engagement.

Deliberation could serve as a potential tool to help address both political differences and a lack of public engagement regarding the management of nuclear waste. This approach is in line with a U.S. Department of Energy program to involve citizens in facility siting, and generally has support within the nuclear energy community (Blue Ribbon Commission, 2012). Indeed, deliberative engagement and similar structures have been helpful in involving citizens in public policy processes on nuclear issues (Berdahl et al., 2016), including waste remediation and the storage of spent fuel (Hamilton, 2004; Maxwell et al., 2004; Carson, 2017). By contrast, other public engagement efforts and traditional "public comment" processes addressing nuclear issues have fallen well short of the ideal for deliberative democratic governance and may exclude some groups and viewpoints entirely (Endres, 2009, 2012; Clarke, 2010; Kinsella et al., 2015). These other experiences underscore the importance of well-designed participatory engagement on this issue, lest a process simply recapitulate the issues of other processes that were not very participatory or democratic.

One well-documented problem with public engagement efforts on nuclear issues is known as the participation gap, which is the large difference between the modest level of participation that

political leaders expect that citizens will want or are capable of, and the much deeper form of participation and consent that citizens actually expect (Kinsella et al., 2015; Trousset et al., 2015). Despite the highly technical nature of nuclear energy and nuclear waste issues (Berdahl et al., 2016), citizens in affected areas seem to want to participate in policy processes on these issues despite a common view among leaders that such issues should be handled primarily by experts (Hamilton, 2004; Trousset et al., 2015). Scholars have also noted that citizens can make useful contributions to policymaking through thoughtfully designed processes and the inclusion of broader forms of public argument so that processes do not privilege scientific/technical language and focus on technocratic decision-making (Kinsella, 2004; Endres, 2009). Open and honest communication, mutual trust between stakeholders, and follow-through on promised decisions all seem to be important in ensuring that citizens will view an engagement process positively and see it as legitimate (Hamilton, 2004). However, questions remain about how citizens and policymakers approach issues of expertise and understanding on such highly technical topics in public engagement contexts (Berdahl et al., 2016; Sprain and Reinig, 2018). For instance, how might citizens respond to a policy recommendation from a citizen deliberative panel when dealing with a highly complex technical issue, rather than a more straightforward policy measure?

Deliberative cues and mini-publics

A deliberative event can help community members who participate in the event become educated about the issue and have more-informed opinions on it (Knobloch et al., 2013). In addition, the outputs of these groups can also help inform a broader public who might be impacted by the decision but could not participate in the event, such as by seeing media coverage of a citizen forum or by reading a report of a panel's recommendations (Gastil, 2014; Gastil et al., 2018). However, it is not clear how well other citizens understand what actually happened in a deliberative event and whether they should trust the output of that process. Participants in deliberative events are often trained to participate, usually during the event, and generally develop an appreciation for this process and its stark differences from many other forms of policymaking. However, deliberative processes still only teach deliberation to the participants present, and the larger public outside is often left seeing a sort of "black box" that produces some deliberative output (O'Doherty and Burgess, 2009). Though there has been some success in influencing public opinion through cues and information generated from deliberative mini-publics (Gastil et al., 2018), it is less clear to what extent citizens might be influenced by a robust description of the deliberative process.

At its best, a deliberative event is described along with its findings to citizens learning about the output of the forum, such as the descriptions provided to the voting public of a British Columbia electoral reform process and an Oregon deliberative process analyzing state ballot measures (Ratner, 2005; Gastil et al., 2014). For example, the Oregon Citizens' Initiative Review process resulted in a statement of key findings and arguments in favor of and against the initiative in question; this statement was included in the state's informational pamphlet about ballot measures and candidates sent to every household with a registered voter. For example, the 2014 Oregon CIR statement included the following introductory description:

> This statement was developed by an independent panel of 20 Oregon voters, chosen at random from the voting population of Oregon, and balanced to fairly reflect the state's voting population. The panel has issued this statement after three and a half days of hearings and deliberation. This statement has not been edited nor has the content been altered (Healthy Democracy, n.d.).

However, it may not always be the case that recipients of information about deliberative processes get such robust descriptions. Often, consumers of political information are left questioning the source and procedure used to reach the findings presented. Even the word deliberation, which has both expert and lay meanings, can be misunderstood if it is not explained well. This lack of understanding can lead to the dismissal of the information provided because of a perception of unsupported claims or a lack of understanding of the process. Given a diversifying media landscape, it has become difficult for the average news consumer to be certain that the information they are receiving is accurate and informative (Kuklinski et al., 2000). Deliberative outputs, when understood, might serve as a more reliable and relatable source of information than others in a given area (Gastil, 2000). Educating the broader public on how a deliberative process works may be an important tool for groups that want larger acceptance of deliberative procedures and greater legitimacy for outcomes produced by deliberative methods. One potential touchstone for recipients of such information could be deliberation in a trial jury, which is common in the U.S. legal system and ubiquitous in popular culture about civil and criminal trials (Gastil et al., 2010). Perhaps greater exposure to the jury deliberation process could leave citizens more supportive of other forms of deliberation.

In addition, perhaps robust descriptions of deliberation can help citizens better understand that such forums can provide them with more ideologically balanced and well-reasoned information and recommendations. Organizers of deliberative forums take steps to help individual participants engage in a process honestly and put aside personal political leanings and biases to learn the information about the topic from a fairly objective viewpoint. Citizens often rely on political cues to make decisions, but those can be tainted by biases and skewed perceptions and understanding of an issue (Nyhan and Reifler, 2010; Jerit and Barabas, 2012). However, it is unrealistic for citizens to have the depth of knowledge needed to fully grasp an issue every time they need to give an opinion or make a decision (Page and Shapiro, 1992). Because participants are engaging in a deliberative process in an authentic way to understand the complexities of a topic and distill information for others, for events with that purpose at least, those outputs could serve as a better source than typical cues such as partisanship or endorsements from interest groups and other political entities (Gastil, 2014).

Though deliberation advocates hope these cues from mini-publics will be broadly helpful to the electorate, there are some indications that individual factors can affect how people respond to

deliberative cues. People getting deliberative information second-hand as a political cue or endorsement are not benefitting first-hand from the preparations and purposeful design of a deliberative process meant to alleviate political polarization and improve open-mindedness, so it stands to reason that their political views and preconceptions could affect how they respond to policy-related information coming from a deliberative event. One survey-based experiment on a real deliberative cue, the Oregon Citizens Initiative Review, showed a substantial decrease in support for a ballot measure that was overwhelmingly opposed by a citizen deliberative panel—though many people initially supportive of the measure remained so after seeing this cue (Gastil, 2014; Gastil et al., 2018). However, a similar study on a county-level deliberative cue found substantial effects on issue-related knowledge, even across partisan and cultural divides (Már and Gastil, 2020). Given the substantial technical complexity and perceived risk of nuclear issues, deliberative cues on these issues might be received differently by the broader public than ones on, for example, statewide ballot measures on criminal sentencing requirements.

Hypotheses

To improve our understanding of the potential for deliberative engagement in the nuclear policy area, we test five hypotheses related to views of different policymaking processes on nuclear waste storage and the potential outcomes of those processes. First, given the sharp divergence noted above between citizens and experts on whether they think citizens will be willing and able to participate in policymaking on nuclear policy, and on the prevailing use of technocratic, scientific decision-making in this domain, we set out to examine how the public views the ability of a citizen-led deliberative panel to make decisions on these issues vs. how they view an expert panel (that is, a panel consisting only of scientists and engineers, without direct citizen involvement) on this same area. Given the general predisposition of those of higher socioeconomic status and greater political involvement, to participate in policymaking processes, we might expect that support for both types of panels will be associated with these variables.

> H1: Support for using citizen panels and expert panels to make decisions on nuclear facility siting will be positively associated with higher socioeconomic status and greater political involvement.

However, we should note that citizen deliberation differs a great deal from many other kinds of political participation, and as such, it may not be well predicted by socioeconomic status and other kinds of political involvement (Neblo et al., 2010).

Next, what factors affect support for a decision made by either a deliberative citizen panel or expert panel to locate a storage facility for spent nuclear fuel near one's community? We anticipate that underlying political values, such as a commitment to egalitarianism, may translate to support for a decision made by a citizen panel, even though such worldviews are also typically associated with pro-environmental and anti-nuclear policy views (Gastil et al., 2011). By contrast, we expect that fatalism, with its attendant views of the world as outside of one's own control, will be associated with support for a decision being made by an expert panel (Trousset et al., 2015).

> H2: Egalitarianism will be positively associated with support for a citizen panel decision to build a nuclear storage facility near one's community.
>
> H3: Fatalism will be positively associated with support for an expert panel decision to build a nuclear storage facility near one's community.

Further, we believe that greater experience with community organizations and civic causes, which can help people learn the value of collective action in solving policy problems, will be associated with support for a decision on a facility siting by either citizen or expert panels. Since many people have no direct experience with a deliberative citizen panel making public policy choices; however, we expect that the closest analogous kind of process—a trial jury—might help some citizens fill in this gap in their knowledge (Gastil et al., 2010).

> H4: Greater activity in community organizations and civic causes will be positively associated with support for either an expert panel or citizen panel decision to build a nuclear storage facility near one's community.
>
> H5: More positive views of a trial jury experience in one's past will be positively associated with support for a citizen panel decision to build a nuclear storage facility near one's community.

Procedure

To test our hypotheses, we use data from a nationwide survey of US residents on energy and environmental issues. The survey, which is part of an annual Energy and Environment Survey (EE) series, was designed by the Center for Energy, Security, & Society at the University of Oklahoma. In the 2014 survey, respondents were asked several questions about jury service and community engagement processes. One policy issue that the EE survey focuses on is nuclear energy, including the storage and transportation of spent fuel and waste, the risks and benefits of nuclear policies, and potential decision-making strategies surrounding nuclear energy. Though several years have passed since these data were collected, much of that intervening time saw the Department of Energy put on hold its consent-based siting efforts for nuclear facility siting during the Trump administration. As noted above, the government has since restarted those efforts under the Biden administration, making it timelier to examine how people view citizen deliberative panels making decisions in this highly technical policy domain.

Participants were recruited through a paid research service, Survey Sampling Inc., which maintains a database of more than six million research respondents in the U.S. The 2014 EE survey was distributed in the U.S. using quota sampling to carefully match the Census for age, gender, ethnicity, religion, and region to best represent the national population. Our sample includes 1,609 participants ranging in age from 18 to 91 ($M = 50.94$). The gender distribution is roughly equal with 45% of the sample identifying

as men and 55% as women. Survey collection took place on June 27–28, 2014, with geographic matching across four census regions: Northeast, Midwest, South, and West.

Measures

The 2014 EE survey included several standard demographic measures included as control variables, including age, education, gender, and a race/ethnicity variable. In addition, there were several participation questions included as controls and variables of interest. Political participation was measured with four items about voting in national and local elections, campaigning for a candidate or political cause, and being active in one's community. All items were dichotomous except community activity, which was measured on a 10-point Likert-type scale of how active one typically is in "local community organizations and civic causes." To examine jury service experiences, participants were first asked if they had "ever served on a jury that deliberated on a civil or criminal case." Those answering yes were asked a second question about how satisfied they were (on a 7-point Likert scale) with their overall experience of serving on a jury. Jury participation and jury satisfaction (satisfied, or 5 and higher, vs. unsatisfied, or 4 and lower) were combined into two dichotomous variables to allow us to examine the role of satisfaction without losing statistical power or artificially anchoring the scale. These Jury Satisfaction and No Jury Participation variables are each relative to unsatisfied jury participation (that is, having served on a jury that deliberated, and also being unsatisfied—answering a 4 or lower on the Likert scale for their satisfaction with jury service).

To measure the cultural worldviews of respondents we used four short statements that summarize the four cultural types including hierarchy, egalitarianism, individualism, and fatalism. Respondents were asked to rate how well each statement describes their outlook on life using a 0 (not at all) to 10 (completely) scale. This measurement of cultural theory has been used in other work examining cultural theory and public participation and has been well-validated as a measure of cultural worldviews in comparison with other measures of cultural theory as well as being predictive of risk judgements (Johnson and Swedlow, 2020; Johnson et al., 2020). Additionally, the variable of risks/benefits of nuclear energy was a single-item measure asking participants to rate the balance of risks and benefits of nuclear energy on a 7-point scale with higher values noting increased benefit over risk.

Participants also read a short description of policymaking on technical issues, explaining both expert and deliberative citizen panels used in the decision-making process, as well as some key arguments for and against each of the panel types (see Appendix). The argument order was randomly assigned and each participant was provided with all four arguments. Respondents were also asked a series of questions focused on preference for using either citizen or expert deliberative panels (or a mix of the two) to make policy around five different social and political issues including the economy, gun control, voter identification laws, vaccinations, and carbon caps. The question wording read: "Thinking about these two types of decision-making processes (the "deliberative citizen panel" and the "technical expert panel"), which of the two, do you think would be best for making public policy decisions in the following areas?" These 5-point items were averaged to serve as a general preference for citizen or expert panel deliberation.

Last, our study used a split design for the key dependent variable measures, which are based on two questions. Half of the respondents were randomly assigned to the condition of an expert deliberative panel deciding on a proposed storage site for spent nuclear fuel and the other half were assigned to the condition of a citizen deliberative panel. In both conditions, respondents were given the same hypothetical scenario: "Assume that a small rural community located about 50 miles away from your primary residence has volunteered to host an interim storage facility for used nuclear fuel." Respondents were then given basic descriptions of either an expert panel process or a deliberative citizen panel process in analyzing a proposed nuclear storage site and deciding on an outcome (see Appendix). Respondents were then given two questions measuring support for the expert (citizen) process and a hypothetical outcome of deciding to build the facility.

The first question focused on support for using the kind of process described: "On a scale of one to seven, where one means *strongly oppose* and seven means *strongly support*, how do you feel about relying on [an expert panel/a citizen deliberative] process to make the decision on whether to build an interim storage facility within 50 miles of your home?" The second question focused on support for the decision by this body to build the storage facility near the respondent's home: "Now, assume that [an expert panel/a citizen deliberative] process has been conducted in your community and the decision has been made to build the storage facility at the proposed site within 50 miles of your home. On a scale of one to seven, where one means strongly oppose and seven means strongly support, how would you feel about the decision to build the interim storage facility at that location?"

To test the hypotheses posed above, we use OLS regression to examine the effects of past jury experience, general support for deliberative processes vs. expert-driven decision-making, views of nuclear energy, cultural worldviews, demographic, and political participation on the support for using either a citizen deliberative panel or an expert panel on deciding the siting of an interim storage facility, as well as the support for or opposition to a hypothetical decision to site a storage facility near one's home.

Results

We first examined support for citizens and experts making decisions regarding nuclear waste management. The results are shown in Table 1. Contrary to our expectations, socioeconomic status and traditional forms of political participation was not associated with support for either a citizen or expert panel process to decide on nuclear waste facility siting. However, gender (male) was associated with support for an expert panel process. Because of this, H1 was partially supported—most of the socioeconomic status variables were not associated with support for either panel type. This may be because of the broad appeal of deliberative innovation (Neblo et al., 2010). The relationship between support for a citizen panel process and self-reported involvement with community organizations and civic causes was significant, at $p < 0.10$, which provides support for H4. Regarding H5, we found that

TABLE 1 Support for citizen and expert panels decision-making.

	Citizen panel	Expert panel
	B (SE)	B (SE)
Intercept	4.630 (0.526)***	0.691 (0.503)
Age	−0.007 (0.004)	0.003 (0.004)
Education	0.046 (0.048)	−0.029 (0.050)
Gender (male)	0.101 (0.121)	0.271 (0.123)**
Race (white)	0.031 (0.158)	0.311 (0.160)*
Income	0.008 (0.078)	−0.018 (0.088)
Ideology (conservative)	−0.020 (0.039)	−0.025 (0.039)
Vote in 2012	0.025 (0.181)	−0.343 (0.176)*
Vote in local elections	0.116 (0.167)	−0.028 (0.153)
Campaign in last election	0.020 (0.173)	0.014 (0.182)
Civic participation	0.044 (0.025)*	0.027 (0.027)
No jury participation (vs. un/satisfied jury)	0.465 (0.207)**	0.216 (0.204)
Satisfied jury participation (vs. no/unsatisfied)	0.580 (0.236)**	0.478 (0.241)**
Hierarchy	0.007 (0.023)	0.019 (0.023)
Individualism	0.027 (0.022)	0.022 (0.022)
Egalitarianism	0.026 (0.021)	−0.029 (0.024)
Fatalism	−0.006 (0.021)	0.058 (0.022)***
Risks and benefits of nuclear energy	0.016 (0.038)	0.262 (0.037)***
Deliberation panel preference (expert)	−0.493 (0.091)***	0.445 (0.089)***
	F (df)	*N*	R^2
Citizen panel model	3.249 (18, 727)***	745	0.074
Expert support model	7.499 (18, 745)***	763	0.153

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

TABLE 2 Support for decision made by citizen and expert panels.

	Citizen panel	Expert panel
	B (SE)	B (SE)
Intercept	1.791 (0.52)***	0.525 (0.472)
Age	−0.009 (0.004)**	0.001 (0.004)
Education	0.098 (0.047)**	−0.015 (0.047)
Gender (male)	0.296 (0.12)**	0.269 (0.115)**
Race (white)	0.083 (0.155)	0.195 (0.15)
Income	0.089 (0.077)	−0.039 (0.083)
Ideology (conservative)	−0.019 (0.038)	−0.017 (0.036)
Vote in 2012	−0.221 (0.179)	−0.207 (0.166)
Vote in local elections	0.101 (0.165)	0.142 (0.144)
Campaign in last election	−0.074 (0.171)	−0.002 (0.171)
Civic participation	0.055 (0.025)**	0.058 (0.025)**
No jury participation (vs. unsatisfied jury)	0.378 (0.205)*	0.147 (0.192)
Satisfied jury participation (vs. unsatisfied jury)	0.761 (0.233)**	0.108 (0.226)
Hierarchy	0.026 (0.023)	0.004 (0.022)
Individualism	0.025 (0.022)	0.007 (0.021)
Egalitarianism	−0.077 (0.021)***	−0.053 (0.022)**
Fatalism	0.012 (0.021)	0.066 (0.02)***
Risks and benefits of nuclear energy	0.387 (0.037)***	0.419 (0.034)***
Deliberation panel preference (expert)	−0.134 (0.09)	0.226 (0.084)***
	F (df)	*N*	R^2
Citizen panel support model	11.392 (18, 729)***	747	0.220
Expert panel support model	13.381 (18, 746)***	764	0.244

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$.

not having served on a jury and having a satisfying jury experience were each associated with increased support for a citizen over an unsatisfying jury experience. This finding provides support for H5.

Though we did not pose hypotheses about cultural worldview and support for either a citizen or expert panel process, we might still expect egalitarians to be generally supportive of greater citizen participation and fatalists to be supportive of experts making decisions without their input. Contrary to our expectations, egalitarianism was not associated with support for a citizen panel process; however, fatalism was associated with support for an expert panel process. Finally, we found that general support for expert-driven decision-making was negatively associated with support for citizen panels and positively associated with support for expert panels.

Next, we examined support for the decision itself across both a citizen panel and an expert panel. This analysis allows us to differentiate support for the decision from support for the process. The results are shown in Table 2. Again, contrary to our expectations, egalitarianism was not positively associated with support for a decision to site a nuclear facility made by a citizen panel. In fact, egalitarianism was significant and negatively associated with support for the decision made by a citizen panel, so H2 was not supported. However, fatalism was positively associated with support for a decision made by an expert panel, supporting H3.

As we hypothesized, experience with community organizations and civic causes was positively associated with support for a decision made by either a citizen panel or an expert panel, providing support for H4. Also in line with our expectations, having served on a trial jury and rating that experience as a more positive one were both associated with greater support for a decision made by a citizen panel, providing support for H5. In addition to these hypothesized relationships, we also found that gender (male) was positively related to support for a decision made by either a citizen

or expert panel; that age was negatively associated with support for a decision made by a citizen panel; and that belief in nuclear energy benefits outweighing the risks was positively related to support for a decision by either type of panel.

Discussion

Though not all of our hypotheses are fully supported, our analysis offers insight into important factors in support of citizen-centered policymaking in nuclear facility siting, as well as providing answers to key questions in the study of deliberative cues for citizens. Given the difficulties associated with Yucca Mountain, the proposed nuclear waste facility that was to be sited in Nevada, nuclear energy policymakers and specifically the Department of Energy have expressed interest in increasing citizen deliberation with consent-based nuclear facility siting (Office of Nuclear Energy, 2021; Department of Energy, 2023). Our findings regarding support for citizen panels and expert panels show that traditional markers of participation like egalitarianism or socio-economic status are not as predictive in the context of nuclear waste, suggesting a broad appeal for a deliberative approach (Neblo et al., 2010). However, fatalism was associated with support for an expert-driven process.

The second set of analyses offers a clear view of support for decisions. It is unrealistic for all participants to be perfectly satisfied when they hold opposing views, but perhaps a robust deliberative process allows participants to feel heard and support process decisions broadly. However, egalitarianism was negatively associated with support for the nuclear waste siting decision that resulted from either a citizen panel or an expert panel. As noted, egalitarians are likely cross-pressured with supporting citizen involvement in decision-making, yet generally not supporting nuclear energy. Therefore, while egalitarians may tolerate a citizen-led process, the outcome is still upsetting, leading to a rejection of a decision that is unaligned with their values. This is the problem complexity that many elected officials face with this issue where community buy-in and genuine citizen participation are necessary to establish long-term solutions.

The expert panel decision was correlated with fatalism as expected. This matches previous work by Trousset et al. (2015) which stated that, "Fatalists are less likely to desire participating in public engagement activities because they believe they have little political efficacy and therefore no real ability to influence policy outcomes" (p. 51). Expert panels remove the responsibility of decision-making from the individual who may already feel a lack of agency and exclusion from political processes broadly (Anderson and Reedy, 2019). A person with high fatalism might feel more confident with a technical individual solving a technical problem for the community. It is also notable that gender (male) was associated with support for either the expert panel or the citizen deliberative panel decision. This is in line with prior research showing that men, white men in particular, are generally more accepting of technological risks such as the risks associated with nuclear energy than other demographic groups (Flynn et al., 1994; Davidson and Freudenburg, 1996; Bord and O'Connor, 1997; Gustafson, 1998; Finucane et al., 2000; Kalof et al., 2002; Olofsson and Rashid, 2011; Nowlin and Conner, 2019). One explanation for the "white-male effect" is that men are generally over-represented among hierarchs, who tend to support nuclear energy, and under-represented among egalitarians, who tend to oppose nuclear energy (Kahan et al., 2010).

We expected that civic participation would be correlated with support for both citizen and expert decisions in part because of a history of seeing and understanding the natural tradeoffs in collective decision-making within the community. Our second set of models shows a similar positive trend for civic participation and support for citizen and expert panel decisions. Civic participation has been linked to trust in institutions (Barrett and Brunton-Smith, 2014) and trust in their community (Putnam, 2001). Expert panels could be seen as a form of institutional process separate from the public because of their composition and removed access from the broader public. In the same way, citizen panels are an extension of the community, and participation in civic life can contribute to trust in the decision-making processes of fellow citizens in a deliberative panel. Part of this support is likely due to the robust description of deliberation provided earlier in the study which allows respondents the opportunity to understand the process and how it, as described, involves citizens or experts in a balanced way. This combined with previous experience in civic life in a community indicates support for deliberative decision-making.

Similar to civic participation, we expected that a positive experience with the most commonly known form of deliberation, jury trials, would also contribute to support for citizen panel decisions. The idea of a courtroom jury is so ingrained as a political institution that even those who have not participated likely associate it with fair outcomes (Gastil et al., 2010). This is likely even more so for those who have participated in a jury and were satisfied with the experience. Exposure to systems where citizen decision-making is embraced helps instill a perception of quality decision-making overall, even when the decision might be unpopular. Perhaps citizen trust in deliberative processes overall can be improved by the spread of deliberation into other domains and jurisdictions, as many people in the area of deliberative civic engagement have suggested (Fung and Wright, 2001; Neblo et al., 2010; Leighninger, 2013).

Collectively our analyses may help scholars and practitioners better understand the usefulness of alternative decision processes and the underlying motivators for support of processes and their decisions. Demographics are only part of the picture, and certainly not as reliable across different approaches to public engagement. Cultural worldview also plays a role (Trousset et al., 2015), but outcomes may still not be supported if the decision is not in line with those values. This can be a "love the process, hate the product" outcome that may always be a struggle between the larger worldview and the natural compromise inherent in collective decision-making, especially on divisive and technical topics like environmental or energy issues. However, it should be noted that it is possible that some people may respond positively to a hypothetical policy process in a survey but would not have the same response should their community actually be faced with a prospective nuclear waste facility.

Understanding the components that encourage the adoption of deliberative processes is important, but developing support for the products of deliberation is arguably more important. Participation

in civic processes is valuable for increasing support for deliberative decisions, but this is not necessarily scalable to large societies. Recent deliberation scholarship has noted that deliberative cues, or the policy recommendations generated by a citizen deliberative panel or forum, can help influence the broader public that was not able to participate directly. Our findings lend further support to this idea and give insight into what factors may affect public response to these deliberative cues. Variables related to exposure to deliberation play an important role in helping individuals support decisions made by deliberative bodies. Evidence from state-level deliberative reforms suggests that these processes lead to greater political efficacy among citizens who are aware of them and able to take advantage of their output (Knobloch et al., 2020). Our findings, taken together with prior scholarship, suggest that infusing more deliberation into civic life could improve public receptiveness to deliberative cues.

It is also important to note that the "participation gap" in nuclear governance is a long-documented issue (Kinsella et al., 2015), and we found further evidence to support the notion that many citizens want input into nuclear policymaking despite its technical nature. Policymakers would be well served to note the trust that people have for their fellow citizens in making decisions in this domain. As trust in institutions and officials has been waning, people seem to still have trust in their fellow citizens. Perhaps institutions could rebuild trust by boosting citizen involvement in domains that historically have been less responsive to the public. Indeed, as noted above, the US Department of Energy has recently developed several new initiatives (e.g., a public Request for Information; funding for research; and the creation of 13 consortia of university, non-profit, and private sector partners) to explore the use of consent-based siting processes for nuclear waste storage to help ensure greater citizen involvement in this historically expert- and elite-driven policy domain (Department of Energy, 2023). Our data come from a period that predates these efforts but were collected in a period in the 2010s when the federal government was first exploring the use of consent-based siting principles before pausing the program during the Trump administration. As such, these findings may have some limitations but do indicate fairly high support for involving citizens in this policy area. From a practical standpoint, our findings suggest that the steps the Department of Energy is now taking to study and implement consent-based siting for nuclear facilities could be especially useful in improving public trust in and support for citizen-led policymaking in this area.

Our findings also encourage further work into the important differences between citizen and expert panel support and support for their decisions. How deliberation is presented to the broader public as these processes are increasingly adopted may prove to be important for boosting support for deliberation. There seems to be a broad base of support for letting citizens be more directly involved in governance processes (Neblo et al., 2010), even in areas that are highly technical and risk-laden (Reedy et al., 2020). As deliberative processes have become more common, more citizens will have first-hand experience with them, but even so, practitioners and scholars should consider the impact of communicating well to the rest of the public about deliberation and its strengths.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving humans were approved by University of Oklahoma - Norman Campus Institutional Review Board. The studies were conducted in accordance with the local legislation and institutional requirements. The participants provided their written informed consent to participate in this study.

Author contributions

JR and CA contributed to conception and design of the study, wrote the survey questions, text related to citizen, and expert panels. All authors contributed to the data analysis, drafting of the manuscript, and manuscript revision. All authors read and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fcomm.2023.1237736/full#supplementary-material

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