Mass Attitudes and the Relationship Between Nuclear Power and Nuclear Weapons

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Abstract

The technical linkages between nuclear power and nuclear weapons have driven policy-making on civilian nuclear energy since the birth of the commercial industry in the 1950s. However, surprisingly little research considers how the two technologies may be linked in mass attitudes. Such inattentiveness is especially problematic in an era where nuclear power continues to be promoted internationally as a means of combating climate change, even as non-proliferation remains a core objective of US foreign policy. In this paper, I use survey experiments run in parallel in the United States and Japan to propose a previously under-theorized explanation of how mass publics relate civilian and military nuclear technologies. Using a multi-staged experimental design with machine-learning methods for efficiency, I construct effective persuasive treatments to assess the effects of persuasive messaging on attitudes toward nuclear power and nuclear weapons in both countries. I find that attitudes toward the two technologies are correlated in both countries, and that negative persuasive messaging yields cross-domain effects among US citizens, providing novel evidence of functional interdependence. Japanese citizens, on the contrary, are resistant to persuasive messaging on nuclear technologies, and show no signs of attitudinal spillover. Together, then, these experiments offer important new insight into the nature of attitudinal constraint among the US mass public, while underscoring the distinctions in constraint across comparative cases.

1 Introduction

In the early 1950s, under the shadow of deepening conflict with the Soviet Union, the Eisenhower administration was keen to shed public memories of the United States' wartime use of nuclear weapons in Hiroshima and Nagasaki. As part of a massive endeavor to transform public opinion, in 1953 Eisenhower delivered his famous "Atoms for Peace" speech, launching the namesake program that would provide civilian nuclear technologies to allies across the world. Over the following years, as US political and industry elites engaged in ranging efforts to promote civilian nuclear energy both domestically and internationally, a central focus remained the redefinition of nuclear energy as a force for peace and prosperity, distinct from the atom's military uses (Boyer, 2005; Cohn, 1997; Medhurst, 1997). The United States was joined in this endeavor by enthusiastic counterparts across the world, but perhaps its most emphatic partners were elites within the Japanese government and fledgling nuclear industry (Kuznick, 2011; Takekawa, 2012; Zwigenberg, 2012). Like their American compatriots, Japanese actors also engaged in extensive promotional activities through the 1950s and 1960s in order to foster support of nuclear power, and distance this civilian use from the shadow cast by weapons that had been used against the country not ten years prior. While these efforts met with considerable early success in both nations, from the 1970s onward, US public attitudes toward nuclear power turned decidedly downward. In contrast, Japanese elites met with broad and lasting success. Acceptance of nuclear power remained high until 2011, shifting only in response to the Fukushima Daiichi Nuclear Power Plant accident, despite extensive opposition to nuclear weapons through the same period.

This comparison raises important questions regarding the nature of mass attitudes toward nuclear technologies (hereafter referred to jointly as "nuclear attitudes") in both the United States and Japan—two distinct nations with interconnected, yet ultimately divergent nuclear histories. Much research has considered the causes of shifting support for nuclear power in the United States (Rankin et al., 1981; Kasperson et al., 1988; Gamson and Modigliani, 1989), while others address differences in mass support for nuclear power in the United States and in Japan (Cohen et al., 1995). However, little work considers the extent to which persuasive messaging may influence attitudes toward nuclear technologies in these countries. In particular, despite numerous informal suggestions that attitudes toward nuclear weapons may influence support for nuclear power in the United States (see, e.g., Pahner 1976; Otway et al. 1978; Kasperson et al. 1980; Slovic 1987; Kasperson et al. 1988; Gamson and Modigliani 1989; see also Boyer 2005; Weart 1988, 2012), only recently have scholars begun to investigate this relationship systematically using experimental methods (Baron and Herzog, 2020). Moreover, although this work provides preliminary evidence of a linkage between attitudes toward the two technologies, it also suffers from methodological constraints that limit the generalizable insights researchers and policymakers might draw from the results.[1]

This article expands considerably upon existing research with evidence from parallel multi-staged experiments conducted in the United States and Japan. Drawing on Converse (1964)'s theory of attitudinal constraint in mass publics, I use persuasive information about both nuclear technologies to examine the extent to which messaging about one technology affects attitudes toward the other. I observe clear evidence of cross-domain effects of anti-nuclear power and anti-nuclear weapons messaging in the United States, indicating a fundamental attitudinal relationship between the two technologies driven by negative messaging (Converse, 1964). Japanese attitudes, however, show no such indication of interdependence. Although the pro-nuclear power message yielded significant positive effects on Japanese citizens' attitudes toward nuclear power, Japanese attitudes toward nuclear weapons are remarkably robust to persuasive messaging.

These results offer to shed new light on the nature of attitudinal constraint in mass publics, contrasting with other recent work that fails to find evidence of interdependence among US citizens (Green et al., 2011; Coppock and Green, 2017), and provides conclusive evidence of the attitudinal

[1] Baron and Herzog (2020), for instance, rely on rudimentary experimental designs conducted on convenience samples. As a result, these results offer only limited insight.

relationship between nuclear weapons and nuclear power in the United States. These findings thus hold important implications for both theory and policy messaging in mass publics. In addition to providing policy-relevant theoretical insights, the article also relies on a novel experimental design featuring a number of methodological innovations for examining public opinion and politically relevant attitudes. This approach, referred to as the Exploratory/Confirmatory Design, disaggregates the research process into multiple phases, allowing the researcher to flexibly and efficiently identify effective experimental manipulations in initial stages, before finally testing hypotheses.

The remainder of the article proceeds as follows. Section 2 introduces the article's theoretical foundation before offering a summary of historical attitudes toward nuclear technologies in both the United States and in Japan. Section 3 describes the Exploratory/Confirmatory Design, and its present application in order to assess persuasive dynamics and attitudinal relationships in both countries. Section 4 presents the results of Study 1, in which I leverage a combination of machine-learning methods with highly factorial treatments in order to identify the sources of attitude formation in each country. Using the combinations of information that most shifted attitudes in each domain, Section 5 presents the results of Study 2. Here, I find the first evidence of a difference in functional interdependence in the United States, versus in Japan. In the United States, even the persuasive messages selected in Study 1 yield strong in-domain effects, and show promising initial signs of functional interdependence. In Japan, in contrast, the corresponding treatments selected in Study 1 fail to yield broad attitudinal effects among respondents. Section 6 proceeds to present results from Study 3, the confirmatory trial, indicating clear cross-domain effects in the United States, but only inconsistent persuasive effects and no evidence of interdependence in Japan. Finally, Section 7 offers concluding thoughts with extensions to nuclear policy between the United States and Japan.

2 Theoretical Motivation and Historical Context

2.1 Theoretical Motivation

The present article draws its theoretical framework from Converse (1964)'s consideration of the relationships between attitudes in mass belief systems. Converse (1964, p. 3) defines these belief systems as "configuration[s] of ideas and attitudes in which the elements are bound together," either by what Converse (1964) goes on to describe as "static constraint"—a relatively thin, solely correlative relationship between idea elements—or interdependence (also referred to as "dynamic constraint")—whereby attitudes toward different concepts are *fundamentally* interrelated and mutually constitutive, such that changing one "*psychologically* require[s], from the point of view of the actor, some compensating change(s)" in related elements of the belief system.

The concept of functional interdependence is critical to the present analysis, because it provides a means of actually identifying the extent to which attitudes toward distinct nuclear technologies are *fundamentally* linked. Static constraint is insufficient to diagnose such a linkage, since attitudinal correlations across domains could merely be a consequence of unobserved confounding factors. For instance, individuals who support both nuclear power and nuclear weapons may do so simply because of an underlying fascination with advanced technologies, without actually considering the two technologies to be linked. On the other hand, if attitudes toward two idea elements are fundamentally connected, then changing attitudes toward one must also influence attitudes toward the other. In the present context, where persuasive manipulations designed to shift attitudes in each domain are randomly assigned, any treatment effects across domains can be attributed to changes in attitudes toward the out-of-domain technology. Such effects would therefore imply an underlying attitudinal linkage between the two technologies, since the only causal pathway through which attitudes shift is through out-of-domain persuasive messaging.

The few experimental studies that directly investigate functional interdependence in mass attitudes find little support for it in mass publics (Green et al., 2011; Coppock and Green, 2017). However, there is reason to believe that attitudes toward nuclear technologies *are* fundamentally linked in the American context. Numerous existing studies note the possibility that US attitudes toward nuclear weapons are related to, or even constitutive of, attitudes toward nuclear energy (Slovic et al., 1976, p. 5; Otway et al., 1978, p. 117; Kranzberg, 1980, p. 330; Kasperson et al., 1980, p. 12; Slovic, 1987, p. 285; Kasperson et al., 1988, p. 185; Gamson and Modigliani, 1989). Pahner (1976) offers an intriguing examination of the relationship from a psychological theoretical perspective, suggesting that opposition to nuclear power stems directly from fears associated with nuclear-arms use. Weart (1988, 2012) presents extensive historical and archival evidence to advance the claim that both nuclear weapons and nuclear power are linked by archetypal imagery of destruction and unnatural human action; whereas Boyer (2005) uses similar methods to point to linkages that existed in the first five years of the Atomic Age. More recently, Baron and Herzog (2020) used a combination of survey and survey-experimental methods to assess the relationship between nuclear attitudes. They provide evidence from a national survey to show that Americans' attitudes toward nuclear technologies are statically constrained, while using convenience-sample surveys to provide initial experimental evidence of interdependence in these beliefs.

While theoretically informative, these studies suffer from various limitations that reduce their suitability as a basis for the present analysis. To begin with, most of these studies are clearly dated, with relatively little new work having been produced in the last several decades. As well, the majority of work positing a relationship between nuclear arms and nuclear weapons in mass attitudes is qualitative, or else relies on solely observational data, making it difficult to discern potential evidence of static constraint from functional interdependence. Although Baron and Herzog (2020) represents a new line of potential research, the insights from this work remain limited: the study's only causal claims rely on a convenience-sample survey using rudimentary, and asymmetrical experimental treatments. Finally, existing work on the attitudinal relationship between nuclear weapons and nuclear power focuses specifically on the United States, meaning still less is known about how nuclear attitudes may be constrained in other national contexts. The present study addresses all of these issues, with new experimental studies conducted in parallel in the United States and Japan. Given the comparative nature of these experiments, the remainder of this section thus provides a historical treatment of mass attitudes toward nuclear technologies in each country, with reference to the foregoing theoretical discussion.

2.2 Historical Attitudes Toward Nuclear Technologies

2.2.1 Nuclear Attitudes in the United States

A centerpiece of American nuclear and foreign policy throughout the 1950s, the Atoms for Peace program served as the vehicle for a massive persuasive messaging campaign with global reach. By all measures, the program was a staggering success in establishing a civilian nuclear energy infrastructure, both domestically and abroad. Moreover, the campaign effectively stoked public enthusiasm regarding civilian nuclear energy. Nonetheless, these triumphs only represented the Atoms for Peace campaign's more superficial objectives; at the core of the program was an intent to more fundamentally transform mass perceptions of nuclear power relative to nuclear weapons. Owing in part to the institutional cohesion of the so-called iron triangle—a subgovernment formed by the pro-nuclear Atomic Energy Commission (AEC), Joint Committee on Atomic Energy (JCAE), and the nuclear industry itself (Baumgartner and Jones, 2009)—the proponents of nuclear power were able to establish an effective monopoly on informational messaging in service of this ultimate goal of disentangling the two technologies. In fact, the debut of Atoms for Peace was itself timed to redirect public attention from new nuclear-weapons developments, such as the new development of the *Nautilus* submarine and the *Castle* series of hydrogen-bomb tests in early 1954 (Medhurst, 1997). Additional efforts to manage mass attitudes toward the two technologies proceeded uninterrupted throughout the remainder of the 1950s, and over the course of the 1960s, with establishment interests using all means at their disposal for reaching mass publics: proponents of nuclear power took to radio, print, television, traveling conventions, and expositions in order to convince the public to embrace the peaceful atom, irrespective of their misgivings regarding its military cousin (Boyer, 2005; Weart, 2012). As the US public came to recognize this distinction, early reticence to adopt nuclear power among utilities also reversed—due in large part to manufacturer guarantees for turnkey projects.[2]

The sweeping reach of AEC and industry messaging during these early years of the commercial nuclear industry helped to establish broad support for the technology that remained high through the 1970s, persisting even through the 1979 Three Mile Island (TMI) accident. At the same time, opinion polls conducted from the early-1970s onward showed growing doubt about the technology among the US public, while mounting anti-nuclear activism introduced a strong voice of active opposition, armed with its own persuasive appeals (Kasperson et al., 1980; Mazur, 1981; Del Sesto, 1983; Joppke, 1993). Previously, large shares of respondents to surveys conducted through the 1970s had been undecided about the technology, providing "Don't know" responses to questions about nuclear power. However, this proportion dwindled as the decade progressed, with uncertain respondents apparently realigning to express critical perspectives on the technology. As the proportion of Americans opposed to nuclear power appeared to be increasing, the TMI accident in 1979 and the 1986 Chernobyl disaster appear to have acted as additional catalysts for anti-nuclear opinion, which has remained high since (Riffkin, 2016; Reinhart, 2019).

Much work has sought to address this secular shift in attitudes toward nuclear power, with a dominant perspective among historical accounts highlighting the role of members of the environmentalist movement. Environmentalist activism against nuclear power began in the 1960s, but

[2] See Cohn (1997); Bupp and Derian (1981); Downey (1986).

entered the political mainstream with full force in the early 1970s, around the time that changes in opinion surveys first become apparent (Kasperson et al., 1980; Joppke, 1993). Early anti-nuclear activism began with grassroots opposition to local siting decisions. With the apparent success of early actions during the 1960s (e.g., toward the Bodega Head plant, which was canceled in 1964; see, as well, Downey, 1986, regarding the local interventions against the Bailly nuclear plant starting in 1972), and the passage of the National Environmental Policy Act of 1969 (Baumgartner and Jones, 2009), the AEC held a series licensing hearings on nuclear plants' emergency core cooling systems (ECCS) in the early 1970s, which environmentalists seized on to publicize safety and regulatory issues Del Sesto (1983). Kasperson et al. (1980) describe these hearings as a rallying point for anti-nuclear activists to form a broad coalition that, by the mid-1970s, had catapulted itself into mainstream national politics. These developments were disastrous for the iron triangle: the AEC was dismantled in 1975, and the JCAE was abolished in 1977 (Kasperson et al., 1980; Baumgartner and Jones, 2009).

The movement thus secured the ability to exert considerable influence over public attitudes toward nuclear power with its own mass persuasive messages (Mazur, 1973, 1981; Kasperson et al., 1980; Joppke, 1993; Weart, 2012). Critically, much of the content produced by the anti-nuclear movement evoked the very linkage between nuclear technologies that the pro-nuclear establishment had spent the preceding decades working to unseat; anti-nuclear activists consistently described nuclear power as unreliable, unsafe, and even deadly (Tamplin and Gofman 1970; Weart 2012, p. 184), both explicitly and implicitly relating the civilian usage of nuclear energy to apocalyptic imagery and appeals associated with nuclear weapons opposition (see, e.g., Croall and Sempler 1979).

It is not possible to identify whether such persuasive messaging by anti-nuclear activists was an important cause of shifting mass attitudes toward nuclear power beginning in the 1970s. Numerous other potential factors have been advanced to explain souring American opinion on nuclear power. For instance, the reality of major delays and cost overruns in plant construction (Cohn, 1997), and the occurrence of salient accidents including the Browns Ferry accident in 1975, TMI in 1979, and Chernobyl in 1986, together made the economic downsides and safety risks of nuclear power increasingly clear to the mass public. With mounting criticism among mainstream media sources (Mazur, 1981; Van Der Pligt et al., 1986; Gamson and Modigliani, 1989), and the collapse of the iron triangle (Baumgartner and Jones, 2009), the support engineered by proponents of nuclear power over the 1950s and 1960s was no longer sustainable with pro-nuclear messaging. However, it is plausible that persuasive messaging linking the nuclear technologies could have affected opinion during this period.

Elite messaging is widely thought to have the power to influence public opinion (see, e.g., DellaVigna and Gentzkow 2010; Zaller 1992; Druckman 2001). Additional indication of the influence of persuasive messaging in the domain of nuclear attitudes is provided by a handful of studies that have utilized information about nuclear energy to assess the influence of psychological features such as attitude accessibility and elaboration. Haugtvedt and Wegener (1994), for instance, assesses the ordering effects of pro- and anti-nuclear persuasive messages, while also manipulating the "personal relevance" of the message, to show that low relevance can yield less-favorable attitudes regarding nuclear power.[3] Though unsurprising in its substantive findings, Fabrigar et al. (1998) find that strong arguments against nuclear power produced significantly more negative attitudes toward the technology than did weak arguments.[4] Additional research examines the role of interest-group politics in shifting attitudes toward nuclear technologies (Del Sesto 1979, 1983; Girondi 1983; see also Mazur 1973, 1981; Gamson and Modigliani 1989; Mazur 1990).

The present study seeks to provide a more direct, and more complete, test of persuasion in this domain. Underlying this investigation is the premise that, while we cannot expect to isolate the historical effect of persuasive messaging in the 1970s on downstream public opinion toward nuclear power, it is possible to test the implications of such historical persuasive effects in current-day settings. If persuasive messaging had no (lasting) effect on mass attitudes, then we will fail to reject the null hypothesis of functional interdependence. On the other hand, to the extent that persuasive messaging linking the two technologies did cause an enduring shift in mass attitudes, we would expect mass publics to continue to hold the belief that nuclear power and nuclear weapons are somehow linked—i.e., functionally interdependent. Of course, this approach remains incomplete: evidence of present-day functional interdependence is still insufficient to identify persuasive messaging about the linkage between the two technologies as the key explanatory factor. Nonetheless, the use of experimental persuasive manipulations to assess functional interdependence in the domain of nuclear technologies still allows us to get some traction on these questions, by exploring the implications of historical persuasive efforts by advocates against nuclear power.

2.2.2 Nuclear Attitudes in Japan

From the mid-1950s onward, Japan expended considerable effort to build up a peaceful nuclear infrastructure, establishing in the process an expansive commercial industry (Kim, 2017). This success was motivated in large part by initial ambition among a cadré of political, technical, and industrial elites to adopt and develop nuclear energy as a means of repurposing the technology for peaceful uses (*heiwateki riyō*; 平和的利用) following the use of nuclear weapons in Hiroshima and Nagasaki. Among these influential elite circles, the Pacific War was often construed as an energy war—resulting from the insecurities posed by Japan's scarce fossil-fuel resources (Yergin, 1991; Kawamura, 2007). In addition to providing a means of reconceptualizing the victimization of the atomic bombings, the promotion of nuclear power thus also offered an opportunity to establish an indigenous fuel source (World Nuclear Association, 2019) that could eliminate the reliance on fossil fuels and transform the broader tragedies of World War II into a force for peace (McCormack et al., 2007; Nelson, 2011; Kurosaki, 2017).

Unsurprisingly, the Japanese public did not immediately regard nuclear power with the same level of enthusiasm as did elites. According to Nelson (2011), a 1956 US Department of State survey found that nearly 40% of Japanese respondents thought nuclear power would do more

[3]The experiment specifically randomized whether a message noted nuclear plants being built in nearby or distant states, as a means of manipulating relevance (Haugtvedt and Wegener, 1994, p. 212). Among subjects in the "low-relevance" group, pro/con message order yielded less-favorable attitudes toward nuclear power; this pattern was reversed among "high-relevance" subjects.

[4]The proximate objective of Fabrigar et al. (1998) was to assess attitude accessibility and argument quality.

harm than good; only 22% believed the benefits outweighed the costs.[5] As in the United States, then, the Japanese "government and electric utilities [sought to promote] the nuclear power option relentlessly, starting a public relations campaign in the mid-1950s that strove to cement a positive image of nuclear power in the public eye" (Nelson, 2011). Paralleling the US experience, Japanese promotional activities ranged from multi-media advertisements, to large-scale expositions, such as an influential 1956 exhibit at the Hiroshima Peace Museum where even atomic-bomb survivors responded enthusiastically to the notion of peaceful uses of nuclear energy (Zwigenberg, 2012). This was, of course, no coincidence. Much Japanese promotional activity drew directly from the Atoms for Peace program (Nelson 2011; Kelly 2014, p. 835). The US and Japanese nuclear industries were also closely affiliated—"four out of the five competing Japanese nuclear groups had links with US firms by 1956" (Kelly 2014, p. 835; see also Samuels 1987; Morris-Suzuki 1994).

Amidst this broad campaign, establishing a distinction between nuclear power and nuclear weapons remained central, and pervaded government messaging on nuclear policy. According to Aldrich (2010), both national and local governments sought further to simultaneously provide the impression of an open venue for citizens to air concerns about the burgeoning technology (as the American AEC had intended to do when it opened its licensing hearings to the public in 1957), while simultaneously stymieing concerted opposition. Exemplifying this approach were numerous town hall meetings where discussion was nonetheless constrained to an already-tight schedule, with all public questions pre-screened and selected by establishment officials well in advance of the meetings themselves (Aldrich, 2010). These efforts were so extensive that they were ultimately reflected in the very language used to describe the technologies: nuclear *power* came to be described almost universally as "atomic" energy (*genshiryoku*; 原子力), in contrast to "nuclear" weapons (*kakuheiki*; 核兵器; Baron, 2016).[6] Interestingly, similar attempts by US industry actors to distinguish "atomic" weapons from "nuclear" energy" clearly failed (Weart, 2012, p. 92).

Indeed, Japanese advocates of nuclear power met with considerable success in the earlier years of the Atomic Age—more so, even, than did their American counterparts. Unlike in the United States, Japanese public support for nuclear power remained strong and stable up until the 2011 Fukushima Daiichi nuclear disaster. In surveys conducted between 1993 and 2011,[7] Kitada (2016, p. 1693) shows that over 65% of the population found nuclear power to be either useful or very

[5] In contrast, a 1948 Gallup poll found 42% of Americans thought atomic energy would do more good than harm. A Roper (1957) poll conducted a year after the referenced Japanese survey found that 20% of Americans surveyed thought atomic energy was "almost sure to bring great benefits to mankind," while 56% at least felt that atomic energy could "help us, only if we use it wisely." Note that the latter question did *not* ask respondents about their views toward atomic power. Instead, respondents were provided the following: "There is a lot of talk that atomic energy can either open up a new era of progress and prosperity, or destroy us all. Which of these statements comes closest to expressing what you think will probably happen in the long range future . . . atomic energy is almost sure to bring great benefits to mankind, atomic energy can help us, but only if we learn to use it wisely, atomic energy is likely to harm us, as it is doubtful whether we will learn to use it wisely, or atomic energy is almost sure to bring destruction through nuclear war?"

[6] The word *kaku* (核) is, however, not-infrequently used to refer to technical elements of the nuclear fuel cycle, e.g., in reference to nuclear reprocessing (*kakusaishori*; 核再処理).

[7] Survey data do not exist for each year in this period. Omitted years include 1994, 1995, 2001, 2008, and 2009.

useful to “Japanese society and daily life.”[8] Through the same period, at least 55% of the population held the view that nuclear power was either good or necessary to utilize. Attitudes toward nuclear power have even remained stable following nuclear accidents. Kotler and Hillman (2000) indicate, for instance, that opinion barely shifted in response to the 1995 Monju Nuclear Power Plant accident; a similar passiveness was observed following the 1997 Tokaimura accident. The Fukushima Daiichi accident does represent an obvious departure. A Pew report from June 2012 showed that 70% of the public support *reducing* the use of nuclear power in Japan (Pew Research Center, 2012).[9] At the same time, support for nuclear power appears to be rebounding (Yamada, 2019), and increased government action aimed at restarting nuclear plants over the last several years has met with little objection from the mass public.[10] Proprietary survey results provided to me by representatives of the Japan Atomic Industrial Forum also suggest a decline in opposition to nuclear power since 2016 (Japan Atomic Industrial Forum, 2019).

While nuclear power has historically maintained considerable support among the Japanese public, citizens also show overwhelmingly negative views toward nuclear arms and nuclear-arms acquisition. A 1999 Gallup poll showed upwards of 80% of Japanese respondents “believe[d] the development of the atomic bomb was a bad thing”; almost 90% said there was no need for Japan to proliferate (Gallup, 1999). According to the 2007 Pew Research Center Global Attitudes survey, 68% of Japanese respondents cited the spread of nuclear arms as the greatest threat to the world (Rosentiel, 2010). Importantly, these attitudes appear to remain highly stable, even in response to major potential shocks. For instance, opposition remained surprisingly high, even in the month following North Korea’s first nuclear test, Mochizuki (2007) describes how national polls showed 80% of the public remained supportive of the three non-nuclear principles, forgoing possession and manufacture of nuclear arms, as well as the introduction of *foreign* nuclear weapons into Japanese territory.[11] The same poll showed that 50.5% of respondents opposed even the positioning of US nuclear weapons in Japan in response to the North Korean threat. According to a *Yomiuri Shimbun* poll cited by Hughes (2007, p. 89), nearly 51% of respondents opposed considering nuclearization, though approximately 46% agreed that debating the question was reasonable. Mochizuki (2007) notes the role of Japan’s national identity as a defense-oriented “peace state.” A more recent survey found that approximately 69% of the Japanese population opposed the state proliferating, even conditional on North Korea maintaining its nuclear arsenal (The Genron NPO, 2017).

Overall, these historical regularities—the clear differences in Japanese attitudes toward military and civilian nuclear technologies, and the impressive stability of these attitudes—hold important implications for the nature of persuasive messaging about nuclear technologies in Japan. The substantial differences in public opinion regarding the two technologies suggests a decoupling of the

[8]The January, 2011 figure was 61%.

[9]Similarly, whereas 46% of respondents supported maintaining nuclear power in 2011, by 2012 that number was down 21 points to 25% (Pew Research Center, 2012).

[10]It is also true that concerns also existed prior to the accident. Over 20% of the population expressed that they were “extremely anxious” about nuclear accidents in nearly every survey presented by Kitada (2016) in the period from 1993 to 2011. Citing a 1999 Prime Minister’s Office poll Kotler and Hillman (2000) describe that 68.3% of respondents expressed being worried about nuclear power generation. On the surface, then, while Japanese attitudes toward nuclear power have historically appeared positive chronic concerns have persisted (Yamada, 2019).

[11]For more information on these principles, announced in 1967 by Prime Minister Eisaku Satō, see Kase (2001) and Chanlett-Avery and Nikitin (2009).

two technologies in mass attitudes—a clear departure from informal claims made by students of US mass attitudes toward nuclear power, as well as by practitioners.[12] This difference could be a consequence of the apparent failure of anti-nuclear voices from constructing a viable movement in the Japanese context. Unlike in the United States, where coherent political action against nuclear power was able to organize into a large-scale movement capable of launching protests and persuasive messaging campaigns on the national scale, no such efforts materialized in Japan. This meant that, until 2011, the majority of nuclear-related messaging in the Japanese context was occupied by the establishment narrative of nuclear power and nuclear weapons as distinct.Given the stability of these attitudes throughout the history of Japanese commercial nuclear energy, we would therefore expect little influence of persuasive messaging in the Japanese context, and especially poor evidence of functional interdependence, with Japanese citizens showing at best a tenuous attitudinal relationship across military and civilian nuclear technologies.

3 Exploratory/Confirmatory Design

3.1 Motivation

As described in Section 2.1, Converse (1964) provides an effective framework for conceptualizing the potential relationship between attitudes toward military and civilian nuclear technologies. Of particular interest is the possibility that these attitudes are functionally interdependent—that is, attitudes toward the two technologies are not simply correlated, but are fundamentally linked among the mass public. Per Converse (1964), interdependence implies a causal relationship in attitudes toward the two technologies, such that a change in one attitude must shift attitudes toward the other. Observational survey data are therefore insufficient to identify such a relationship: while survey evidence can provide information about static constraint by revealing attitudinal correlations across domains, the potential for confounding means that an observational analysis alone cannot reliably identify a fundamental causal linkage in respondents' attitudes across domains (Green et al., 2011; Coppock and Green, 2017).

Converse (1964)'s conceptualization of functional interdependence therefore lends itself naturally to an experimental design, whereby the experimenter can measure the extent to which manipulations designed to shift attitudes toward *one* idea element yield cross-domain effects—shifting attitudes toward the *other* element. In the context of nuclear attitudes, such persuasive manipulations should seek to respectively shift attitudes toward nuclear power and toward nuclear weapons, in order to identify whether persuading the public about one technology yields a concomitant shift in attitudes toward the other. The design requirements to identify functional interdependence are therefore somewhat basic; a two-armed trial—with attitudes toward each technology measured following random assignment of a persuasive message about either nuclear weapons or nuclear power—would be sufficient. In the present case, I employ a slightly more complex, 2×2 design to assess both positive and negative persuasive messages about each technology (i.e., power/weapons $\times$ pro-/anti-nuclear).

[12] See Baron (2020, Ch. 2) for a review of commentary made in congressional hearings through the 1970s.

Unfortunately, implementation is less straightforward in this case. The existing literature on nuclear attitudes in the United States highlights several topics that appear to be salient predictors of nuclear attitudes more broadly (e.g., the waste problem with nuclear energy; Rankin et al., 1981); as noted above, evidence from a handful of studies provides evidence that persuasive messaging can shift attitudes toward nuclear power (Haugtvedt and Wegener, 1994; Fabrigar et al., 1998). However, those studies that do assess the effects of persuasive messaging on nuclear attitudes do little to identify the specific types of information that are most influential (see also Crater 1977 and Showers and Shrigley, 1995 for findings from related, non-experimental studies). Less apparent still is how combinations of informational messages may interact to differentially influence nuclear attitudes.

3.2 Design

Rather than designing interventions based on ambiguous or limited empirical findings, the validity of which may be questionable, I adopt a data-driven approach to identifying effective combinations of persuasive information for use as experimental treatments. Modern surveying and statistical-learning approaches allow us to assess the effects of numerous, interacting factorial treatments, and to identify those combinations that appear most effective in moving attitudes. Unfortunately, due to the relatively high costs of subject recruitment, it would be difficult to implement a highly factorial experiment with enough subjects to attain sufficient statistical power for inference.

In order to balance these constraints, I employ a multi-staged experimental design which I refer to as the Exploratory/Confirmatory Design. The Exploratory/Confirmatory Design seeks to improve the performance of treatments for causal inference while reducing potential costs associated with surveying by disaggregating treatment selection and hypothesis testing into three major phases. In a first stage of exploratory testing, highly factorial treatments are fielded using convenience samples (*Exploratory Stage*).[13] In a second *Calibration Stage*, statistical-learning methods are then employed in order to identify the most effective treatments or treatment combinations. Instruments are then adjusted and fielded on distinct samples for confirmatory hypothesis testing (*Confirmatory Stage*).

The Exploratory/Confirmatory Design is therefore similar in conceit to an adaptive experimental design, with similar benefits (Offer-Westort et al., 2019). For instance, improving the effectiveness of the treatments used in subsequent trials provides gains in statistical power, since these improved treatments should yield larger and more easily detectable effects in later stages. As demonstrated by the multi-staged experiments presented below, the Exploratory/Confirmatory Design can be effectively implemented with small convenience samples at surprisingly low cost. It should be noted, however, that issues of external validity may remain when relying on convenience samples in the Exploratory or Calibration Stages. In the present case, these stages are represented by Study 1, which uses data from small samples from Amazon Mechanical Turk and CrowdWorks. While recent work suggests that Mechanical Turk workers may not differ substantially from the American public more generally (Levay et al., 2016), important distinctions remain, and so the

[13] The Exploratory Stage can feature an arbitrary number of pilot or convenience-sample studies; see, e.g., Baron and Herzog (2020).

insights drawn from these convenience samples may not generalize to the national population (Berinsky et al. 2012; Huff and Tingley 2015; see also Cheung et al. 2017).[14] Using larger, more representative samples in these initial stages would reduce these concerns, though uncertainty of course remains as a consequence of sampling variance.

Aside from the technical benefits, the Exploratory/Confirmatory Design also offers potential gains to flexibility and transparency in research design. Much work has emphasized the benefits of exploratory research prior to confirmatory analysis, including in the social sciences (see, e.g., Tukey, 1977, 1980; Behrens, 1997; Stebbins, 2001; Wagenmakers et al., 2012). In this sense, the Exploratory/Confirmatory Design does not represent a fundamentally novel approach, nor is it a departure from this tradition. However, the multi-staged approach promotes a conceptual distinction between exploratory and confirmatory phases, while explicitly incorporating both processes into a single work-flow. The Exploratory/Confirmatory Design provides flexibility in exploratory phases of analysis, allowing the researcher to adjust analysis procedures and design in order to improve instruments and build theoretical propositions and testable hypotheses, before tying their hands in advance of actual confirmatory testing. This means that the Exploratory/Confirmatory Design process also interfaces effectively with existing best practices, including pre-registration (Olken, 2015) and the use of standard-operating procedures (SOPs; Lin and Green 2016). Finally, the Exploratory/Confirmatory Design is agnostic to the specific methods chosen by the researcher. The Design is perhaps best-suited to experimental research, as it is employed in the present circumstance. However, the approach represented by the Exploratory/Confirmatory Design could ostensibly be used in other contexts, as long as researchers are able to distinguish exploratory from confirmatory samples. The Exploratory/Confirmatory Design can also be used in qualitative settings, or employed in mixed-methods research agendas.[15]

3.3 Present Use and Implementation

This article applies the Exploratory/Confirmatory Design concept in three sequential studies, presented in turn below.[16] Study 1 combines Exploratory and Calibration Stages. I used a highly factorial convenience-sample survey in each country in order to assess the influence of multiple types of persuasive information on subjects' attitudes. Subjects were randomly assigned to one of the four main treatment arms represented by the 2×2 factorial design (pro-/anti-nuclear message $\times$ nuclear power/nuclear weapons),[17] where the message itself could include up to four informational paragraphs, each regarding a distinct aspect of the given technology, with inclusion of a given paragraph determined by coin flip (with equal probability of inclusion/exclusion). Using

[14] For this reason, caution is advised, and the results of Calibration should not be over-interpreted, unless Exploratory trials were fielded with nationally representative samples. In this case, however, treatment selection in the Calibration Stage can be informative for inductive theory-building, by revealing the nature of the most effective treatments in shifting attitudes. This can provide insight into the causal pathways at work in persuading subjects.

[15] For example, the present design draws largely from in-person interviews and historical research conducted in both the United States and Japan.

[16] In fact, Study 1 builds on a series of pilot studies. See Baron and Herzog (2020) for further discussion.

[17] In the United States, a placebo vignette was also fielded. Because placebo responses did not differ substantially from pure control, the Japanese Study 1 survey, and subsequent surveys, did not include placebo arms.

Bayesian additive regression trees (BART; Chipman et al. 2010), I then modeled the effects of each combination of informational paragraphs, and selected those combinations that yielded the largest effect estimates for each arm. Study 2 fielded follow-up convenience-sample surveys in each country using the selected messages, providing an opportunity to begin hypothesis testing in each country before moving to full, national samples. Study 3 represents the final, Confirmatory Stage. Using the same messages employed in Study 2, I conducted a national survey in both countries in parallel in order to verify the cross-domain effects of persuasive information regarding civilian and military nuclear technologies. The remainder of the paper presents these studies and their findings before offering a series of conclusions for theory and practice.

4 Study 1

The Study 1 trials were conducted on Mechanical Turk from October 6, 2018 through October 15, 2018 with a total of 505 subjects,[18] and on CrowdWorks from May 5, 2019 through May 7, 2019 with a total of 499 subjects. Japanese respondents were compensated at a rate of ¥50 per complete, whereas US respondents were compensated at a rate of $1.00 per complete.[19] The survey instruments and results from calibration with BART are described in detail below.

4.1 Study 1 Design

In order to identify the most persuasive combinations of information, respondents were treated with a factorial message composed of between zero and four randomly selected paragraphs, each containing information on a distinct topic related to either nuclear power or nuclear weapons. These informational paragraphs represent a selection of topics emphasized in-person interviews, archival and historical materials (including existing survey work), and modern persuasive materials from pro- and anti-nuclear advocates. I employ informational treatments specifically for at least four reasons. First, it is more straightforward to manipulate the specific aspects of persuasive messages in text-based informational treatments than it would be with visual stimuli. Second, information presents a low risk of psychological harm to subjects, whereas other forms of persuasive messaging—such as graphic imagery associated with nuclear-weapons use—could be disturbing. Third, informational treatments do not require any deception; as I show below, both pro- and anti-nuclear arguments are often staked on the same informational foundations, though this information may be interpreted differently. Finally, in practice, the use of informational treatments constitutes a harder test, relative to the use of other persuasive treatments, such as imagery or video. Relative to striking visual imagery both in favor of and against nuclear technologies, informational text is likely to be less salient to respondents; thus, to the extent that even informational messages can

[18] A technical error in the `MTurkR` batch-recruiting algorithm employed during the recruitment period allowed a small number of subjects to repeat the survey. These respondents' original responses were preserved while eight duplicative responses were dropped.

[19] Mechanical Turk's suggested market rate is $.50/5 minutes; $1.00 represents market rate for the US survey, which included additional questions after outcome measurement, not discussed here, lasted approximately ten minutes. The survey instruments were otherwise kept as similar as possible.

move subjects' attitudes across domains, it is highly likely that we would observe stronger effects in the real world.

The set of informational topics used to compose treatment messages in Study 1 is presented in Table 1, and the complete selection of topic paragraphs is presented in both English and Japanese in Appendix A.[20] These topic paragraphs are referenced below according to the titles shown in Table 1, formatted in bold.

Table 1: Exploratory Study 1 Vignette Themes by Technology

		Topic		
		Power	Weapons	Placebo (US Only)[20]
Paragraph	1	Radiation	Deterrence	Atoms
	2	Waste	Safety	Electrons
	3	Accidents	Environment	Nuclear Physics
	4	Economics	Proliferation	Nuclear Reactions

Note that information topics were held constant across technology types. Table 2 provides an example, by way of comparison between the pro- and anti-nuclear versions of the **Radiation** topic paragraph. Both versions include comparable information about the risks posed by radioactive releases from nuclear power plants, but these facts are interpreted differently, in accordance with the valence of the parent treatment. Other paragraphs were composed in a similar manner. For instance, the pro-nuclear weapons version of the **Deterrence** paragraph describes the alleged benefits of nuclear deterrence for defense and international stability, whereas the anti-nuclear weapons version of the paragraph instead contends that deterrence does not have a stabilizing effect on international politics, and in fact poses a threat to peace. This symmetry across pro- and anti-nuclear messages within domains ensures greater comparability of the treatment effects of each topic paragraph.

Each topic paragraph was written so as to avoid cross-domain spillover, as failure to do so could itself induce cross-domain attitudinal correlations, even in the absence of preexisting associations. Such a violation would of course undermine the validity of the experimental results. As a consequence, all topic paragraphs were carefully composed to avoid all explicit references to the technologies' dual-use characteristics.[21] For instance, neither version of the **Proliferation** topic paragraph explicitly describes the possible diversion of weapons-usable material from nuclear reactors. Instead, both pro- and anti-nuclear versions of the paragraph only discuss the possible

[20] Full topic paragraphs for each arm are presented in both English and Japanese in Appendix A. The US survey also featured a parallel placebo treatment regarding the history of nuclear physics, with thematic paragraphs respectively describing the discovery of atoms, the discovery of electrons, the birth of the field of nuclear physics, and the concept of the nuclear chain reaction. Only the last two paragraphs use the word "nuclear," without reference to nuclear weapons or nuclear power. The inclusion of the term "nuclear" in two of the placebo paragraphs was meant to assess whether the mere mention of the word "nuclear" would yield observable effects on subjects' attitudes. The placebo messages did not differ substantially from pure control, and so the placebo arm was excluded from further trials.

[21] Each paragraph was also reviewed by colleagues with substantive and technical knowledge of peaceful and military nuclear technologies. I thank Stephen Herzog, Juraku Kohta, and Maki Sato for their assistance in this review.

Table 2: Comparison of Pro- and Anti-Nuclear Power Radiation Paragraphs

Pro-Nuclear Power Paragraph	*Anti-Nuclear Power Paragraph*
Contrary to popular belief, nuclear power poses little health risk from radiation. We are constantly exposed to natural radiation—from the ground, from cosmic rays, and even from the food we eat. In fact, a person living within 50 miles of a nuclear power plant for a year is exposed to less radiation than they would get from eating a banana, which naturally contains radioactive potassium. All the nuclear power plants in the world emit only a fraction of the natural environmental radiation that people are exposed to. A typical nuclear power plant in the United States doesn't even release enough radiation to cause one cancer death per year.	Natural radiation exists all around us, but nuclear power plants expose the public to excess radiation each day. Nuclear power adds an unnecessary, unnatural source of radiation into our environment, posing serious health risks. While natural environmental radiation can cause cancer, people living close to nuclear power plants are exposed to higher doses of radiation—the closer a person lives to a plant, the greater their exposure. A typical nuclear power plant in the United States releases enough radiation to cause around one cancer death per year that would otherwise be avoided.

acquisition of fissile materials by rogue states or non-state actors, e.g., via theft of existing nuclear warheads.

The treatment text was also written to avoid other, clear logical connections between the two technologies. This allows me to more reliably identify cross-domain effects as a consequence of an underlying *psychological* association between the two technologies, rather than as a result of learning. For example, it would be problematic if the **Accidents** paragraphs described the possibility of radioactive fallout, because subjects reading these paragraphs might logically associate the risks of fallout posed by nuclear power plants and those posed by nuclear-weapons detonations. As such, the **Accidents** paragraphs avoid all explicit linkages between the two technologies, and instead solely discuss the risk of accidents in nuclear power plant operation. While it is not possible to rule out the possibility that respondents could still draw relationships between accidents at nuclear reactors and the risks associated with nuclear weapons, the lack of a direct connection between the two technologies in the treatments themselves implies that such "learning" would itself have to stem from preexisting associations between the two technologies., such that learning about one technology allowed them to update their beliefs about the other.

As well, the text for each treatment paragraph was carefully composed in order to avoid informational spillover between *topics*. For example, the **Accidents** paragraphs describe the health impacts of nuclear disasters, but without explicitly mentioning radiation, since **Radiation** comprises a separate topic paragraph. Cross-topic spillover effects would not invalidate estimates of the persuasive effects of selected treatments, but accounting for all potential spillover effects is important for the purposes of identifying which topics most influence attitudes. Again, it remains difficult to completely rule out the possibility of spillover across topics. For this reason, in addition to issues of generalizability presented by the use of convenience samples here, I avoid a deeper theoretical interpretation of Study 1's results. Comparisons to conventional technologies were also omitted, e.g., between nuclear power, renewables, and fossil fuels. This ensured that any observations of functional interdependence in later stages was attributable purely to the relationship between attitudes toward nuclear power and those toward nuclear energy—and not a result of having activated distinct attitudes.

The actual message presented to a given respondent was determined by randomly assigning the subject to one of the four main treatment arms, and then selecting topic paragraphs by simple random assignment with even probabilities, using the custom-coded `factorial-assign` JavaScript package designed for use with this and related survey studies (Baron, 2019). Within each arm, then, a subject could receive one of 2^4 potential combinations of topic paragraphs, implying a $2 \times 2 \times 16$ factorial design, with 64 distinct treatment "profiles."[22] Subjects assigned to zero topic paragraphs saw no vignette prior to answering outcome questions. Accordingly, all such individuals were considered as pure-control subjects.

4.2 Measurement

The primary outcomes of interest were measured using attitudinal batteries regarding each technology ("technology batteries"). The battery text, composed based on historical public opinion surveys regarding nuclear power and nuclear weapons, is shown in Table 3. The batteries posed six questions about nuclear power or nuclear weapons, respectively; these questions were kept as parallel as possible across technology types. Battery order and question order within battery were both randomized. In order to simplify analysis, I averaged the responses to each technology battery into a corresponding attitude index.[23] I then summed the two indices into a combined attitude index.[24]

4.3 Calibration

After collecting results from the Study 1 survey, I used BART (Chipman et al., 2010) to select the most effective treatment profiles in each first-order arm. BART is able to flexibly and automatically model nonlinearity in and interactions between treatments, reducing biases from improper model selection or changes in tuning parameters (Green and Kern, 2012). BART has also been successfully employed in the survey-experimental context (Green and Kern, 2012), and has been shown to operate effectively in contexts of high-dimensional treatments with rich covariate sets (Hill, 2011). In fact, Green and Kern (2012, p. 508) specifically note that "BART is particularly appropriate when the search for systematic variation in treatment effects is not guided by strong theory," fitting the current exploratory setting.

[22] The US survey featured 80 total profiles, including the 16 placebo-message combinations.

[23] Formally, for each technology $t \in \{\text{power}, \text{weapons}\}$, the index $Y_{t,i}$ represents the average of each subject $i \in \{1,...,N\}$'s responses to the battery's six attitudinal questions $A_{t,j,i}$, $j \in \{1,...,6\}$: $Y_{t,i} = \frac{1}{6}\sum_{j=1}^{6} A_{t,j,i}$. This produced two index vectors of length N pertaining to each technology type t.

[24] The combined attitude index, $Y_{comb,i} = \sum_t Y_{t,i}$.

Table 3: English and Japanese Attitudinal Batteries

Power Battery Questions

Please rate your attitudes toward the following statements related to ***nuclear power****.*

The United States should continue to research and develop new nuclear power plant designs.
The United States should continue to use and maintain nuclear power plants.
I would feel comfortable living near an active nuclear power plant.
The United States should use nuclear power to serve national energy interests.
The environmental risks of nuclear power are not worth the benefits.
The United States should build *more* nuclear power plants.

次の**原子力**に関する意見について賛成か反対かを答えてください。

日本は原子力発電の新技術に関する研究と開発を続けるべきだ。
日本は原子力発電所を稼動し続けるべきだ。
稼動中の原子力発電所の近くに住むことに不安を覚えない。
日本は国家エネルギー保障のために原子力発電を使用するべきだ。
原子力発電は環境への影響より利点の方が大きい。
日本はより多くの原子力発電所を建設するべきだ。

Weapons Battery Questions

Please rate your attitudes toward the following statements related to ***nuclear weapons****.*

The United States should continue to research and develop new nuclear weapon designs.
The United States, should continue to store and maintain nuclear weapons.
I would feel comfortable living near a military installation where nuclear weapons are stored.
The United States should use nuclear weapons to serve national security interests.
The environmental risks of nuclear weapons are not worth the benefits.
The United States should build *more* nuclear weapons.

次の**核兵器**に関する意見について賛成か反対かを答えてください。

日本での核兵器の継続的な研究、開発、そして保管。
アメリカは核兵器を保持し続けるべきだ。
核兵器の収納された軍基地の近くに住むことに不安を覚えない。
日本は国家安全保障のために核兵器を使用するべきだ。
核兵器は環境への影響より利点の方が大きい。
日本は核兵器を製造するべきだ。

Conceptualizing each of the main treatment arms as separate experiments, I produced a matrix of potential combinations of topic paragraphs, representing the 16 possible treatment profiles within each arm. I then modeled the treatment effects of each profile, thereby accounting for interaction effects. I fit the models using Chipman and McCulloch (2016)'s `BayesTree` package for R, with modest augmentations to the recommended default settings,[25] and outcomes residualized using available covariates.[26] Each model was fit using the three attitude indices described above, both with and without constraints on the number of topic paragraphs to be selected.

For each iteration of the MCMC algorithm, BART returns a series of draws from a joint posterior, corresponding to each treatment profile. Averaging over the posterior draws of all MCMC iterations therefore produces a mean posterior value for each treatment profile. I replicated each fit 1,000 times, averaging the results for each treatment profile over the 1,000 iterations. I then selected the treatment profiles that yielded the most extreme mean posterior values (for pro-nuclear arms, this was the largest positive value; for anti-nuclear arms, it was the largest negative value).[27]

4.4 Findings and Discussion

I begin by assessing descriptive statistics regarding attitudes toward the two technologies in each country. Table 4 presents baseline attitudinal measures for both power and weapon attitude indices in each country. Several observations are apparent from these results. To begin with, US respondents were, on average, more pro-nuclear than were Japanese respondents. This is especially apparent of attitudes toward nuclear power, where US respondents revealed neutral-to-positive perspectives, in contrast to Japanese citizens' clearly negative perspectives.[28] Although respondents in both countries were broadly opposed to nuclear weapons, Japanese respondents again indicated substantially more negative views.

Study 1 also afforded a first opportunity to assess static constraint in nuclear attitudes comparatively in both countries. Results are presented in Table 5 and Table 6, which respectively show the estimated correlations from the US and Japanese surveys. Both surveys indicated robust, positive correlations between attitudes across power and weapons domains. This was particularly the case among US respondents, who showed strong associations across technology types.[29] These cor-

[25] I used 500 MCMC burn-in iterations and 1000 posterior draws following burn-in, each of which featured 500 trees to compute the summed result. Each resulting fit was replicated 1000 times. Due to the computational complexity of the algorithm, I employed the `foreach` package in R to parallelize the operation, producing 50 replications over each of 20 cores, for all three outcomes mentioned below.

[26] The conditioning sets used in the United States and in Japan differ due to the availability of covariates. Restricting the US conditioning set does lead to some differences in BART selection; however, the mean posterior values change only modestly, suggesting that the combinations are equally effective in shifting attitudes, and that differences arise from low precision.

[27] I also processed data by indicating the best-performing combination in each iteration, then selecting the profile that was most frequently selected over all 1,000 iterations as the overall best-performing message. Results did not change between the two approaches.

[28] Though, it is interesting that Japanese respondents were positive about building more nuclear plants, given their negative attitudes in every other context.

[29] Similar question batteries fielded on a national survey in the United States produced similar results. These findings are presented in Baron and Herzog (2020).

Table 4: Study 1 Baseline Attitudes by Domain and Context

	R&D	Use	Live Near	National Interest	Environmental Impact	Build (More)
Power Index						
United States	−0.008	0.185	0.508	−0.478	0.681	0.649
	(0.09)	(0.085)	(0.086)	(0.093)	(0.083)	(0.083)
Japan	−1.301	−0.580	−0.353	−1.307	−0.418	0.243
	(0.061)	(0.068)	(0.070)	(0.067)	(0.072)	(0.074)
Weapon Index						
United States	−1.155	−0.724	−0.528	−0.819	0.050	−0.387
	(0.085)	(0.088)	(0.086)	(0.089)	(0.088)	(0.087)
Japan	−1.685	−1.622	−1.775	−1.707	−1.514	−1.221
	(0.072)	(0.069)	(0.066)	(0.07)	(0.073)	(0.075)

relations were somewhat weaker among Japanese respondents, although all correlations remained positive, and the associative patterns were similar.

Table 5: Correlation Matrix of US Attitudes by Domain and Context

		Weapons					
		R&D	Use	Live Near	National Interest	Environmental Impact	Build (More)
Power	R&D	0.539	0.523	0.473	0.504	0.470	0.394
	Use	0.498	0.508	0.460	0.472	0.455	0.378
	Live Near	0.435	0.446	0.691	0.414	0.500	0.461
	National Interest	0.491	0.485	0.464	0.474	0.436	0.373
	Environmental Impact	0.526	0.554	0.529	0.500	0.557	0.429
	Build	0.513	0.517	0.567	0.505	0.518	0.508

Table 6: Correlation Matrix of Japanese Attitudes by Domain and Context

		Weapons					
		R&D	Use	Live Near	National Interest	Environmental Impact	Build (More)
Power	R&D	0.428	0.356	0.248	0.279	0.276	0.375
	Use	0.400	0.362	0.318	0.329	0.321	0.374
	Live Near	0.337	0.346	0.512	0.336	0.340	0.365
	National Interest	0.412	0.371	0.270	0.343	0.302	0.378
	Environmental Impact	0.382	0.360	0.254	0.337	0.378	0.387
	Build	0.461	0.465	0.369	0.436	0.430	0.493

Calibration with BART revealed further interesting comparisons between the two samples.[30] Since estimates computed using the combined attitudes index outcome yielded the largest effects, overall, this section results computed with the power or weapons attitude indices are omitted here.[31] As indicated by Figure 1, which shows the BART estimates of every message's effects on the combined attitude index for each survey, two-paragraph messages yielded the largest effects

[30] I do not focus here on first-order treatment effect estimates, given the small sample size. However, these results are presented in Appendix B.

[31] Results with all outcomes are presented in Appendix C.

in almost all cases. These messages are indicated with black arrows. There was one exception in each respective survey, indicated with pink arrows: in the US survey, the best-performing pro-nuclear weapons message included three paragraphs;[32] in the Japanese survey, the best-performing pro-nuclear energy message included all paragraphs. However, as is visible in Figure 1, the differences between two- and three-paragraph messages in these two cases were relatively small. In general, estimates were fairly stable, irrespective of the number of paragraphs, and were almost always signed correctly. Since two-paragraph messages were clearly the most effective messages overall, however, I proceeded by selecting only the best-performing two-paragraph messages in each arm for further analyses. This ensured greater symmetry across all treatment arms, while also imposing a lower burden on subjects' attention.

Figure 1: BART Effect Estimates

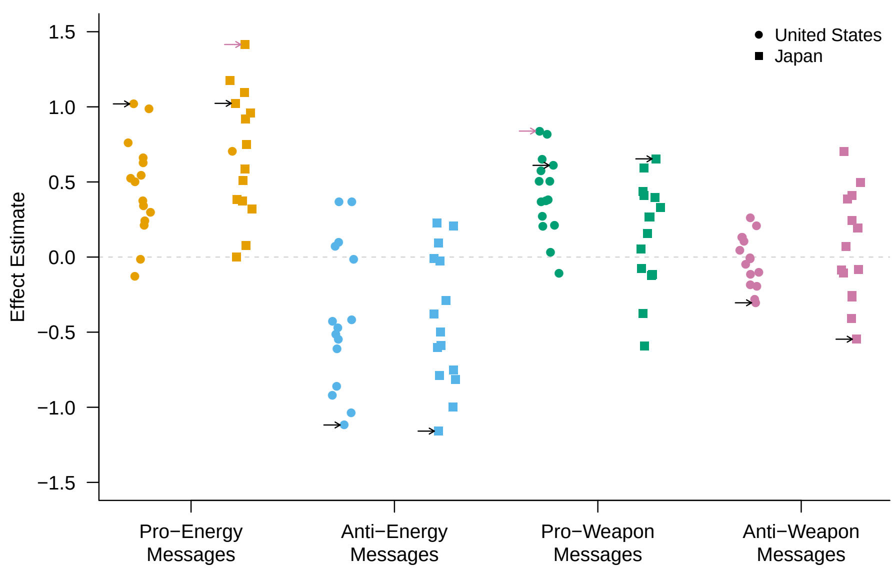

Table 7 and Table 8 present the selected messages for each arm in each survey, along with the corresponding effect estimates.[33] As already suggested, each of the four main treatments returned a mean posterior in the anticipated direction, regardless of the chosen outcome measure. This provides an encouraging initial sign that all interventions operated as intended, in both countries. In fact, the US and Japanese results were surprisingly similar.

Further comparison between the two surveys shows greater differences in the substantive infor-

[32]The message included information on deterrence, the environmental effects of nuclear arms, and associated proliferation risks; the best-performing two-paragraph message excluded the paragraph on proliferation.

[33]Full results, showing mean-posterior estimates, are provided in Appendix C. The effect estimates provided here are computed by differencing the pure-control estimates (−0.161 in the United States; −0.116 in Japan) from the mean-posterior estimates.

Table 7: Selected Energy-Treatment Messages

	Radiation	Waste	Accidents	Economics	Effect Est.
Pro-Energy Treatment					
United States	✓	✗	✗	✓	1.020
Japan	✓	✗	✗	✓	1.023
Anti-Energy Treatment					
United States	✗	✓	✗	✓	−1.118
Japan	✗	✓	✓	✗	−1.159

Table 8: Selected Weapon-Treatment Messages

	Deterrence	Safety	Environment	Proliferation	Effect Est.
Pro-Weapon Treatment					
United States	✓	✗	✓	✗	0.610
Japan	✗	✓	✓	✗	0.654
Anti-Weapon Treatment					
United States	✓	✗	✗	✓	−0.304
Japan	✓	✓	✗	✗	−0.547

mation that was most effective in persuading subjects in each sample. Although the most effective pro-nuclear power message was the same in both American and Japanese contexts, the two groups otherwise showed substantive differences. Regarding the anti-nuclear power message, Japanese and American respondents were both persuaded by information regarding nuclear waste. However, for Japanese respondents, information regarding accident risks was apparently more effective in moving attitudes, whereas the economic pitfalls of nuclear energy yielded a greater impact for US respondents. Given the salience of Fukushima, this result is unsurprising,[34] though it is interesting that information about accident risks was not as effective in shifting nuclear-power attitudes in the United States, even despite evidence that Fukushima has had wide-reaching effects on attitudes (see, e.g., Wittneben, 2012).

Similarly, results pertaining to the nuclear-weapons vignettes showed some overlap, but also distinct divergence. The pro-nuclear weapon message that most influenced attitudes in the United States included information about both deterrence and the environmental footprint of nuclear weapons. While environmental considerations featured into the most effective pro-nuclear weapon

[34] In fact, this may serve as an additional robustness check.

message in the Japanese survey, Japanese respondents were apparently more influenced by information regarding the safety of storing nuclear arms. The selected anti-nuclear weapon vignettes also differed across countries: Americans' attitudes were most influenced by critiques of nuclear weapons along the lines of deterrence, as well as information about the threat of nuclear proliferation; Japanese respondents were also persuaded by information highlighting the potential failures of deterrence, but for all outcomes, information on safety was also selected.

In concert, these results do suggest some similarities in Japanese and American respondents' attitudes toward nuclear technologies. Both samples showed similar associations across technology types; there was also overlap in the types of information that shifted attitudes. Nonetheless, notable differences remain. At baseline, Japanese respondents were appreciably more negative about nuclear technologies than were Americans. The cross-domain attitudinal correlations were also somewhat weaker in Japan than they were among US respondents. Finally, information on nuclear-power accident risks, and the safety of nuclear-arms storage was apparently more salient to Japanese respondents, suggesting deeper substantive divergence between the two populations.

5 Study 2

5.1 Study 2 Design

Study 2 sought to assess the effects of the messages selected in Study 1 in two respective convenience-sample surveys conducted in the United States on August 14, 2019; and on August 15, 2019 to August 16, 2019 in Japan. The surveys were both conducted with 500 subjects, with US subjects recruited through Amazon Turk Prime, and Japanese respondents using CrowdWorks.[35]

After consenting to the experiment and answering the same covariate measures included in Study 1, respondents were randomly assigned to one of five treatment arms: either one of the four arms implied by the 2×2 interaction of pro-/anti-nuclear and power/weapons factors, or pure control. Outcomes were measured with the same attitudinal batteries employed in Study 1, with order randomized.

5.2 Measurement and Hypothesis Testing[36]

In both countries, I estimated results using OLS regression, both with and without regression adjustment using demographic covariates and responses to politically relevant questions. For each survey I estimated effects with the two following models. Model 2.1 estimates the effect of each treatment, compared to pure control, on the power attitude index:

[35] As in Study 1, US respondents were compensated $1.00 per complete. Japanese respondents were compensated at a rate of ¥50 per complete.

[36] Much of the text appearing in Section 5.2 and Section 5.3 is nearly identical to that included in the Study 3 pre-analysis plan, registered with Evidence in Governance and Politics (EGAP).

$$
\begin{aligned}
Y_{\text{power},i} = &\beta_0 + \beta_1 \times \text{pro-power}_i + \beta_2 \times \text{anti-power}_i + \\
&\beta_3 \times \text{pro-weapon}_i + \beta_4 \times \text{anti-weapon}_i + \\
&\beta_5 \times \mathbf{X}_i + \varepsilon_i,
\end{aligned}
\tag{2.1}
$$

where $\mathbf{X}_i$ represented the conditioning set, chosen from the null set (i.e., no covariates), or the vector of demographic and politically relevant covariates noted above. Model 2.2 similarly estimates the effect of each treatment, compared to pure control, on the weapon attitude index:

$$
\begin{aligned}
Y_{\text{weapon},i} = &\gamma_0 + \gamma_1 \times \text{pro-power}_i + \gamma_2 \times \text{anti-power}_i + \\
&\gamma_3 \times \text{pro-weapon}_i + \gamma_4 \times \text{anti-weapon}_i + \\
&\gamma_5 \times \mathbf{X}_i + \eta_i.
\end{aligned}
\tag{2.2}
$$

ε_i and η_i represent the respective error terms of Model 2.1 and Model 2.2.

5.3 Hypotheses

Using these models, I specify three main hypotheses. The first is that there is attitudinal spillover between nuclear-power and nuclear-weapons treatments:

Hypothesis 1 (*spillover*): $(\beta_3 - \beta_4) + (\gamma_1 - \gamma_2) > 0$.

This test statistic provides a summary of spillover between nuclear-power attitudes and nuclear-weapons attitudes. Under the null hypothesis of no spillover across domains, this statistic will be equal to zero. If there is attitudinal spillover, this statistic will be positive. For each technology, I also assess the average causal effect (ACE) of moving from an anti-nuclear message to a pro-nuclear message on attitudes toward the alternative technology:

Hypothesis 2a (*spillover (weapons)*): $(\beta_3 - \beta_4) > 0$;

Hypothesis 2b (*spillover (power)*): $(\gamma_1 - \gamma_2) > 0$.

Under the null hypothesis of no out-of-domain effects, these differences will be equal to zero. If the effect of pro- versus anti-nuclear information affects out-of-domain attitudes in either case, the corresponding difference will be positive. The ACEs estimated in *Hypothesis 2a* and *Hypothesis 2b* boost statistical power, because they exploit the maximal contrasts between nuclear-weapon treatments and nuclear-power treatments, respectively. This is also true of the *Hypothesis 1* estimate, which is equivalent to the average of both out-of-domain effects.

These inferential targets are also substantively informative. In real-world settings, individuals are somewhat unlikely to be treated with solely pro-nuclear information or anti-nuclear information regarding a given technology. Comparison of messages of either valence to pure control is therefore somewhat contrived; contrasting pro- and anti-nuclear arguments, within domains, constitutes a more naturalistic target. As such, *Hypothesis 1*, *Hypothesis 2a*, and *Hypothesis 2b* constitute my primary hypotheses. Nonetheless, I do examine the effects of individual treatments on cross-domain attitudes estimated in Model 2.1 and Model 2.2:

Hypothesis 3a (power-attitude effects): $\beta_1, \beta_3 > 0$ and $\beta_2, \beta_4 < 0$; and

Hypothesis 3b (weapon-attitude effects): $\gamma_1, \gamma_3 > 0$ and $\gamma_2, \gamma_4 < 0$.

Since pro-nuclear vignettes should have a positive effect on attitudes in both domains, and anti-nuclear vignettes should have a negative effect on attitudes in both domains, all hypothesis testing proceeds using one-tailed tests.[37] For *Hypothesis 1*, *Hypothesis 2a*, and *Hypothesis 2b*, where I expect positive point estimates, I use one-tailed, upper tests. For *Hypothesis 3a* and *Hypothesis 3b*, I use one-tailed, upper tests for pro-nuclear treatments, and lower tests for anti-nuclear treatments. All hypothesis testing proceeds with significance level $\alpha = 0.05$, and HC2 robust standard errors.

5.4 Findings and Discussion

Unlike Study 1, the findings of Study 2 reveal a clear distinction between attitudes among US and Japanese respondents. These findings are presented in Table 9; the results of hypothesis testing from both surveys are presented in Table 10. The estimates from the US Study 2 survey are, in fact, similar to those estimated using BART in Study 1. I observe substantial and significant effects of spillover across nuclear power and nuclear weapons domains (Table 10). This is all the more impressive, given the survey's small size, and commensurately low statistical power—though, these results should be interpreted with caution, since the study was fielded using a convenience sample that cannot be expected to represent the broader population.

In contrast, we cannot reject the null hypothesis of no attitudinal spillover in the Japanese survey (Table 10). The estimates pertaining to *Hypothesis 2a* and *Hypothesis 2b* shed light on the nature of this null finding: neither nuclear-power messages nor nuclear-weapons messages had an out-of-domain effect. This is apparent, as well, when considering individual effect estimates—there is little evidence of possible cross-domain effects. Table 9 does show that there is a positive and significant effect of pro-nuclear power information on nuclear power attitudes. Nuclear-weapons messages also yielded similar point estimates for effects in both Japanese and American contexts, with the pro-nuclear weapons message making respondents modestly more positive about nuclear power, and the anti-nuclear weapons message having a close-to-zero effect in both samples. However, the two groups diverged substantially when it came to nuclear-*weapons* attitudes. Pro-nuclear weapons messages had a significant and positive effect on American respondents' attitudes toward nuclear weapons; nuclear-power information also yielded positive point estimates. Conversely, Japanese respondents' attitudes toward nuclear weapons remained immobile—neither nuclear-weapons messages, nor nuclear-power messages had any measurable effect on Japanese respondents' nuclear-weapons attitudes.

Looking to individual treatment effects, Table 9 shows that both pro- and anti-nuclear power treatments tended to yield attitudinal effects in the anticipated directions in the United States. Both pro- and anti-nuclear power messages appeared to have large within-domain effects, but cross-domain effects were not significant (likely due to low statistical power). Overall, nuclear-weapons messages appeared unpersuasive. In the United States, the pro-nuclear weapon message

[37] The use of one-tailed tests for hypothesis testing was also stated in the preregistration of Study 3 (see Olken 2015, p. 70 on the commitment to one-tailed tests in preregistered designs).

Table 9: Study 2 Estimated Treatment Effects

	United States		*Japan*	
	Undjusted	Adjusted	Undjusted	Adjusted
Power Index‡				
Pro-Power	0.567	0.503	0.407	0.403
	(0.241)	(0.219)	(0.192)	(0.171)
Pro-Weapon	0.203	0.279	0.164	0.225
	(0.241)	(0.228)	(0.180)	(0.164)
Anti-Power	–0.549	–0.536	–0.256	–0.232
	(0.232)	(0.217)	(0.195)	(0.176)
Anti-Weapon	0.012	–0.033	0.012	0.038
	(0.243)	(0.230)	(0.191)	(0.164)
Weapon Index‡‡				
Pro-Power	0.127	0.107	–0.098	–0.112
	(0.218)	(0.175)	(0.195)	(0.177)
Pro-Weapon	0.408	0.428	–0.118	–0.044
	(0.214)	(0.175)	(0.189)	(0.175)
Anti-Power	–0.206	–0.151	–0.233	–0.216
	(0.205)	(0.172)	(0.211)	(0.198)
Anti-Weapon	–0.053	–0.071	–0.106	–0.072
	(0.215)	(0.176)	(0.196)	(0.179)

‡ The theoretical and actual range of the Power Index was $[-3,3]$ in both the United States and Japan. The US mean and standard deviation (SD) were 0.118 and 1.690, respectively. The Japanese mean and SD were -0.612 and 1.342, respectively.

‡‡ The theoretical and actual range of the Weapon Index was $[-3,3]$ in the United States. The theoretical range was the same in Japan, but the actual range was $[-3,2.833]$. The US mean and SD were -0.732 and 1.526, respectively; the Japanese mean and SD were -1.376 and 1.331, respectively.

HC2 robust standard errors are presented in parentheses under the corresponding point estimates.

had a significant effect on subjects' in-domain attitudes. No such effect was observed in Japan; in fact, the point estimate of the pro-weapon message was negative (though this result should not be over-interpreted, given the large standard error estimate on the coefficient). In neither survey did anti-nuclear weapon messages yield substantial effects.

It is important to recall that these surveys were conducted with small convenience samples, and the results therefore cannot be expected to generalize to the broader populations of either country. In general, however, the differences observed between US and Japanese samples have promising implications for Study 3: as expected, the American survey showed clear indications of attitudinal spillover, suggesting a fundamental association nuclear energy with nuclear weapons. Conversely, even though we observed positive *correlations* in cross-domain attitudes, Japanese subjects' views on nuclear technologies show little sign of *interdependence*, suggesting a delineation between the

Table 10: Study 2 Hypothesis Testing

Hypothesis	Test	*p*-value (United States)	*p*-value (Japan)
H1: Spillover	$(\beta_3 - \beta_4) + (\gamma_1 - \gamma_2) > 0$	0.020	0.118
H2a: Spillover (Weapons)	$(\beta_3 - \beta_4) > 0$	0.130	0.325
H2b: Spillover (Power)	$(\gamma_1 - \gamma_2) > 0$	0.114	0.178
H3a: Effects on Power Index			
Pro-Power	$\beta_1 > 0$	0.011	0.009
Pro-Weapon	$\beta_3 > 0$	0.111	0.085
Anti-Power	$\beta_2 < 0$	0.007	0.093
Anti-Weapon	$\beta_4 < 0$	0.443	0.592
H3b: Effects on Weapon Index			
Pro-Power	$\gamma_1 > 0$	0.271	0.737
Pro-Weapon	$\gamma_3 > 0$	0.007	0.599
Anti-Power	$\gamma_2 < 0$	0.191	0.138
Anti-Weapon	$\gamma_4 < 0$	0.344	0.344

All hypothesis testing conducted with one-tailed tests, with adjusted estimates and $\alpha = .05$. All standard errors, except for Spillover, were computed as HC2 robust standard errors. The standard error estimate for the Spillover test statistic was computed using a bootstrap with 10,000 iterations.

two technologies in Japanese attitudes.

6 Study 3 (Confirmatory Trial)

Study 3 was comprised of the two Confirmatory experimental trials, fielded in parallel in Japan and the United States for the purposes of final hypothesis-testing on national samples. The US survey was fielded from January 12 to January 17, 2020 with a representative sample of 2,500 subjects recruited by YouGov/Polimetrix. The Japanese survey was fielded January 12 to January 20, 2020 with a general population sample of 3,043 subjects recruited by Dynata (formerly Survey Sampling International; SSI), balanced on key covariates, including age, gender, and region. Both surveys included a wash-out selection of unrelated questions between treatment assignment and outcome measurement.

6.1 Measuring Effects[38]

Effects were estimated using OLS as in Study 2, with some modest augmentations. For the US Study 3 survey, all estimates were computed with survey weights provided by YouGov. Because Dynata did not provide survey weights for sampled respondents in Japan, all analyses from the Japanese survey are unweighted.[39]

[38] The studies are described in a pre-analysis plan, registered at EGAP prior to surveying. Section 6.1 is largely identical to the measurement detailed in the pre-analysis plan.

[39] Again, however, sample recruitment was balanced on key covariates including age, gender, and region.

Effects were estimated using the two specifications shown below.[40] Model 3.1 estimates treatment effects on the power index, compared to the baseline of pure control, controlling for key covariates:

$$\begin{aligned}Y_{\text{power},i} = &\beta_0 + \beta_1 \times \text{pro-power}_i + \beta_2 \times \text{anti-power}_i + \\ &\beta_3 \times \text{pro-weapon}_i + \beta_4 \times \text{anti-weapon}_i + \\ &\beta_5 \times \text{female}_i + \beta_6 \times \text{pid}_i + \beta_7 \times \text{ideo}_i + \\ &\beta_8 \times \text{education}_i + \beta_9 \times \log(\text{income}_i) + \\ &\beta_{10} \times \text{age}_i + \varepsilon_i.\end{aligned} \tag{3.1}$$

Model 3.2 estimates treatment effects on the weapon index, compared to the baseline of pure control, with the same controls:

$$\begin{aligned}Y_{\text{weapon},i} = &\gamma_0 + \gamma_1 \times \text{pro-power}_i + \gamma_2 \times \text{anti-power}_i + \\ &\gamma_3 \times \text{pro-weapon}_i + \gamma_4 \times \text{anti-weapon}_i + \\ &\gamma_5 \times \text{female}_i + \gamma_6 \times \text{pid}_i + \gamma_7 \times \text{ideo}_i + \\ &\gamma_8 \times \text{education}_i + \gamma_9 \times \log(\text{income}_i) + \\ &\gamma_{10} \times \text{age}_i + \eta_i.\end{aligned} \tag{3.2}$$

ε_i and η_i represent the respective error terms of Model 3.1 and Model 3.2. All hypothesis-testing proceeded as in Study 2 (see Section 5.2 above), with directional hypotheses.

6.2 Findings and Discussion

I begin by presenting descriptive results from the Study 3 surveys. As shown in Table 11, the American public is generally positive about nuclear power, while showing clear signs of opposition to living near nuclear plants, as well as modest opposition to building more nuclear power plants. Interestingly, the national sample of American adults also shows a somewhat nuanced set of attitudes toward nuclear weapons. Americans have weak but positive support for continued nuclear-weapons research and development, storage and maintenance, and relatively positive views on the environmental impact of nuclear-arms use. At the same time, Americans clearly feel negatively about the idea of living near military bases where nuclear arms are stored, and about building *more* nuclear weapons; citizens are also weakly opposed to using nuclear weapons to protect national security.

In contrast, the national sample of Japanese adults shows quite similar baseline attitudes toward nuclear technologies relative to the convenience sample recruited to the Study 1 survey. Japanese respondents are opposed to both nuclear power and toward nuclear weapons, across the board, with attitudes toward nuclear weapons once again showing particularly strong opposition. Notably, Japanese attitudes toward living near nuclear power plants, and toward building more nuclear power plants, show similar baseline opposition to the corresponding questions about nuclear

[40] Unadjusted estimates are also reported, but do not represent the primary inferential targets.

Table 11: Study 3 Baseline Attitudes by Domain and Context

	R&D	Use	Live Near	National Interest	Environmental Impact	Build (More)
Power Index						
United States	0.610	0.522	-0.734	0.415	0.090	-0.084
	(0.038)	(0.037)	(0.041)	(0.036)	(0.037)	(0.039)
Japan	-0.086	-0.581	-1.140	-0.524	-0.595	-1.127
	(0.033)	(0.032)	(0.032)	(0.032)	(0.031)	(0.030)
Weapon Index						
United States	0.144	0.383	-0.873	-0.071	0.423	-0.596
	(0.039)	(0.039)	(0.040)	(0.039)	(0.038)	(0.037)
Japan	-0.984	-0.820	-1.433	-1.381	-1.395	-1.317
	(0.0351)	(0.033)	(0.033)	(0.033)	(0.031)	(0.033)

weapons. The particularly strong anti-nuclear power attitudes in these contexts is likely a consequence of the Fukushima Daiichi nuclear accident.

These differences in baseline attitudes notwithstanding, Table 12 and Table 13 once again show broad consistencies in static constraint in both US and Japanese contexts. One obvious deviation from prior results shown in Table 12 is the series of *negative* correlations in Americans' nuclear attitudes toward the technologies' environmental impacts. This negative correlation could potentially result from shifting attitudes among environmentalists toward nuclear power: whereas environmentalists have historically opposed nuclear power, the technology has gained acceptance among environmentalists because of its potential use as a carbon-neutral energy source to combat climate change. In all other contexts, however, we observe similar estimates to those computed previously, in both the United States and in Japan. Indeed, we generally find strong, positive correlations in attitudes toward nuclear technologies in Japan. In both countries, then, Study 3 provides clear evidence that nuclear attitudes are statically constrained.

Table 12: Correlation Matrix of US Attitudes by Domain and Context

		Weapons					
		R&D	Use	Live Near	National Interest	Environmental Impact	Build (More)
Power	R&D	0.595	0.559	0.414	0.529	-0.319	0.538
	Use	0.576	0.627	0.428	0.549	-0.332	0.554
	Live Near	0.475	0.512	0.685	0.501	-0.371	0.575
	National Interest	0.459	0.480	0.374	0.498	-0.255	0.471
	Environmental Impact	-0.312	-0.346	-0.308	-0.324	0.578	-0.375
	Build (More)	0.469	0.497	0.414	0.459	-0.296	0.557

What of functional interdependence? Table 14 presents the main results from both Study 3 survey experiments; the results of hypothesis testing are shown in Table 15. As in Study 2, the results from the US and Japanese surveys diverge sharply. The US survey yielded strong and significant results, largely consistent with the hypotheses developed in Study 2. The test statistic of spillover, computed from the global test detailed in *Hypothesis 1*, was highly significant ($p < 0.001$), confirming that Americans' attitudes toward nuclear power and those toward nuclear weapons are functionally interdependent. This finding remains strong when we consider the effects of per-

Table 13: Correlation Matrix of Japanese Attitudes by Domain and Context

		Weapons					
		R&D	Use	Live Near	National Interest	Environmental Impact	Build (More)
Power	R&D	0.490	0.487	0.397	0.488	0.441	0.480
	Use	0.453	0.507	0.417	0.512	0.472	0.480
	Live Near	0.351	0.444	0.643	0.438	0.459	0.514
	National Interest	0.369	0.487	0.445	0.484	0.460	0.535
	Environmental Impact	0.365	0.466	0.476	0.466	0.485	0.545
	Build (More)	0.414	0.506	0.442	0.505	0.468	0.542

suasive messaging *within* domain (*Hypothesis 2a* and *Hypothesis 2b*). Both power and weapon ACEs are positive and significant (respectively, $p = 0.001$ and $p = 0.018$). Clearly, then, this attitudinal linkage between nuclear technologies is bidirectional. As observed in Study 2, however, the cross-domain effects of nuclear-power messaging on nuclear-weapons attitudes are larger (and more highly significant) than are the effects of nuclear-weapons messaging on nuclear-power attitudes. That is, Americans perceive a clearer connection between both technologies, but messaging about nuclear power is more likely to influence attitudes toward nuclear weapons than the other way around.

Interestingly, the point estimates for both the spillover summary statistic, and the ACEs for each technology type are remarkably similar to those computed in Study 2, suggesting: a.) that the differences between the persuasive effects of pro- and anti-nuclear messaging may be similar across various (sub)segments of society; and, b.) that spillover effects remain stable across these demographics. Turning to the effects of individual persuasive messages on attitudes in each domain, however, we observe substantial differences between Study 2 and Study 3. With the exception of the pro-nuclear weapon message's effect on nuclear-power attitude index (which was substantively small and insignificant), all individual effect estimates remained correctly signed. Substantively, however, the two samples were persuaded by somewhat different informational messages. In Study 3, the only messages that had significant effects on nuclear-power attitudes (after adjusting for covariates) were anti-nuclear messages, though the pro-nuclear power message did have a weakly significant effect on nuclear power attitudes in the unadjusted specification. Notably, both anti-nuclear power and anti-nuclear weapons messages did have significant effects on power attitudes—once again anchoring the observation of functional interdependence among the US public by showing that negative messaging about *either* nuclear technology yields a concomitant, negative effect in support for nuclear power. In the case of nuclear-weapon attitudes, both pro- and anti-nuclear weapons messages yielded significant in-domain effects, showing that Americans can be convinced to be either more favorable or more opposed to nuclear weapons. More importantly, the anti-nuclear power message also had a significant negative effect on nuclear weapons attitudes, once again underlining the main theoretical assertion that attitudes toward nuclear power and those toward nuclear weapons are linked in respondents' minds. As noted above in Section 4.1, it is difficult to fully distinguish whether this linkage is a consequence of some fundamental, psychological linkage between the two technologies, or whether messaging about one technology provides subjects with sufficient information to update their beliefs about the alternative technology by learning. However, such a mechanism would nonetheless imply that beliefs about the

Table 14: Study 3 Estimated Treatment Effects

	United States		*Japan*	
	Unadjusted	Adjusted	Unadjusted	Adjusted
Power Index†				
Pro-Power	0.161	0.144	0.205	0.180
	(0.095)	(0.094)	(0.084)	(0.077)
Pro-Weapon	–0.024	–0.021	0.175	0.112
	(0.098)	(0.093)	(0.086)	(0.078)
Anti-Power	–0.326	–0.378	0.074	0.053
	(0.099)	(0.098)	(0.086)	(0.079)
Anti-Weapon	–0.245	–0.244	0.146	0.156
	(0.102)	(0.099)	(0.085)	(0.078)
Weapon Index‡‡				
Pro-Power	0.153	0.150	0.113	0.094
	(0.096)	(0.091)	(0.082)	(0.077)
Pro-Weapon	0.158	0.194	0.133	0.078
	(0.098)	(0.091)	(0.085)	(0.079)
Anti-Power	–0.149	–0.212	0.050	0.030
	(0.098)	(0.095)	(0.084)	(0.080)
Anti-Weapon	–0.176	–0.164	0.042	0.049
	(0.098)	(0.094)	(0.083)	(0.078)

‡ The theoretical and actual range of the Power Index was $[-3, 3]$ in both the United States and Japan. The US mean and standard deviation (SD) were 0.136 and 1.256, respectively. The Japanese mean and SD were -0.681 and 1.458, respectively.

‡‡ The theoretical and actual range of the Weapon Index was $[-3, 3]$ in both the United States and Japan. The US mean and SD were -0.098 and 1.262, respectively; the Japanese mean and SD were -1.232 and 1.443, respectively.

HC2 robust standard errors are presented in parentheses under the corresponding point estimates.

two technologies are correlated at the individual level, such that learning about one technology elicits consideration of the alternative technology. Since the persuasive messages used throughout the experimental design explicitly avoided direct linkages between the two technologies, any such learning would still necessarily rely on *existing associations* between the two technologies in respondents' minds. Ultimately, then, the interdependence in attitudes observed here is strongly suggestive of a fundamental attitudinal linkage between the two technologies in the mass public.

In contrast to the US survey results, the Japanese survey yielded largely null results, indicating no attitudinal spillover globally (*Hypothesis 1*), nor directionally as represented by the power and weapon ACEs (*Hypothesis 2a* and *Hypothesis 2b*). In fact, the the weapon ACE was incorrectly signed with a negative point estimate, and all point estimates of the effects of anti-nuclear messages were positive. These estimates may appear bizarre in light of Study 2's results, where albeit insignificant point estimates were all negative. The estimates in Study 3 largely appear to be a

Table 15: Study 3 Hypothesis Testing

Hypothesis	Test	p-value (United States)	p-value (Japan)
H1: Spillover	$(\beta_3 - \beta_4) + (\gamma_1 - \gamma_2) > 0$	<0.001	0.427
H2a: Spillover (Weapons)	$(\beta_3 - \beta_4) > 0$	0.018	0.679
H2b: Spillover (Power)	$(\gamma_1 - \gamma_2) > 0$	0.001	0.247
H3a: Effects on Power Index			
Pro-Power	$\beta_1 > 0$	0.062	0.010
Pro-Weapon	$\beta_3 > 0$	0.587	0.077
Anti-Power	$\beta_2 < 0$	<0.001	0.751
Anti-Weapon	$\beta_4 < 0$	0.007	0.977
H3b: Effects on Weapon Index			
Pro-Power	$\gamma_1 > 0$	0.050	0.111
Pro-Weapon	$\gamma_3 > 0$	0.016	0.162
Anti-Power	$\gamma_2 < 0$	0.013	0.646
Anti-Weapon	$\gamma_4 < 0$	0.041	0.735

All hypothesis testing conducted with one-tailed tests, with adjusted estimates and $\alpha = .05$. All standard errors, except for Spillover, were computed as HC2 robust standard errors. The standard error estimate for the Spillover test statistic was computed using a bootstrap with 10,000 iterations.

consequence of relatively strong anti-nuclear sentiments among the control group. The unadjusted control-group averages of the power and weapons attitudes indices were -0.804 and -1.301, respectively. As a result, while attitudes toward both nuclear technologies remained negative for all treatment groups, the average among control subjects was of a larger magnitude than that of any other group. With this being said, the estimated effects of the pro-nuclear energy message on attitudes in domain were positive and significant. This estimate suggests a receptiveness among the Japanese public to persuasive messaging in favor of nuclear power, and has potential ramifications for mass persuasion campaigns by industry or the government, as the Abe administration continues to restart nuclear plants throughout the country nine years after the Fukushima Daiichi accident.

In general, the Japanese survey reveals unclear evidence of functional interdependence—the tests associated with *Hypothesis 1*, *Hypothesis 2a*, and *Hypothesis 2b* all yield null results, confirming the suspicions formed in Study 2, that the Japanese public does not appear to systematically relate the two technologies. At the same time, we observe some potential signs of spillover in the estimated effects of nuclear-weapons messages on nuclear-power attitudes in Study 3. The anti-nuclear weapons message yielded a large and positive effect on nuclear-power attitudes that is weakly significant according to a two-tailed test ($p = .046$). This finding runs contrary to our theoretical predictions and warrants further examination—though it is plausible that, if Japanese respondents truly do consider nuclear weapons and nuclear power separate, anti-nuclear weapons messaging may enhance the relative acceptability of nuclear power. Nonetheless, even with these apparent aberrations, the null hypothesis of no functional interdependence cannot be rejected (*Hypothesis 1*, *Hypothesis 2a*, and *Hypothesis 2b*).

Overall, then, the results from these two surveys offer clear empirical support of the implications of the theory laid out above, that persuasive messaging that links nuclear weapons and nuclear power creates enduring associations in mass attitudes toward the two technologies. In Japan, where such messaging has historically been minimal and anti-nuclear power activists have largely been excluded from the political discourse, we observe a Japanese public with unrelated, and highly stable, views on both military and civilian nuclear technologies. The US public, in contrast, is substantially more receptive to persuasive information, and shows clear evidence of spillover across domains; Americans fundamentally relate nuclear power and nuclear weapons, such that messaging about one technology also imposes a shift in attitudes toward the other technology.

7 Conclusion

Prior research on constrained beliefs in mass attitudes has failed to find evidence of functional interdependence, even in the presence of strong static constraint. In contrast, the studies presented here provide conclusive evidence of functional interdependence in American attitudes toward nuclear technologies, offering new insight into enduring questions regarding the nature of beliefs in mass publics. Moreover, this interdependence appears to rest on a fundamental, psychological association between the two technologies—instead of some logical coherence between the two technologies alone. Yet, where the US public shows a clear connection in attitudes toward nuclear power and nuclear weapons, Japanese respondents show little evidence of such a linkage. This distinction is particularly interesting in light of the fact that US and Japanese samples show largely comparable *correlations* in attitudes across domains. A further examination suggests that the persuasibility of these publics may be a contributing factor. American attitudes toward nuclear technologies are somewhat flexible, with anti-nuclear messaging yielding particularly strong effects both within and across domains. While Study 3 showed that Japanese citizens can be persuaded to be more supportive of nuclear power after reading positive persuasive information about the technology, Japanese attitudes toward nuclear weapons remain unaffected by even strong persuasive messaging about each technology.

The contrasts in spillover among Japanese and American samples suggest a fundamental difference in how the two mass publics conceptualize, and relate, nuclear technologies. The clear evidence of functional interdependence in the United States is consistent with the historical success of anti-nuclear persuasion campaigns that tied military and civilian technologies together. These campaigns may have had lasting effects on US attitudes toward both technologies. While these results alone cannot be used to identify the effects of historically different courses of mass messaging on nuclear technologies in the two countries, if this narrative is true, then the apparent strength of this cross-domain linkage in 2020 is a testament to the ranging influence of persuasion campaigns that gained full steam in the 1970s—and to the potential of persuasive messaging to establish enduring attitudinal relationships. The findings in the United States thus hold potentially extensive implications for theories regarding the influence of persuasive messaging on mass attitudes. To the extent that attitudes in any domain are functionally interdependent, mass messaging in one policy context could have unintended consequences for attitudes in other domains, potentially yielding lasting opinion shifts in multiple, interrelated policy domains.

On the other hand, the lack of an apparent connection between Japanese attitudes toward nuclear power and those toward nuclear weapons may signify the potential for elite actors to *stymie* attitudinal interdependence: pro-nuclear interests in Japan used consistent persuasive messaging over decades in an effort to shape mass support for nuclear power while nonetheless maintaining strong condemnation of nuclear weapons.[41] To the extent that the results presented here indicate the success of these efforts, then these findings also indicate the ability of elites to engineer mass belief systems in order to reduce or eliminate attitudinal relationships.

Regardless, the difference in attitudinal linkages in the United States and Japan has further ramifications for US-Japanese diplomacy, and particularly for ongoing policy discussions regarding the US-Japan alliance and the countries' involvement in global commercial nuclear energy production. In the context of the US-Japan relationship, the difference in US and Japanese results suggests that US concerns regarding Japan's commercial nuclear industry may be overstated. Japanese attitudes toward nuclear weapons are solidly negative, robust to strong persuasion, and show little relationship to attitudes regarding nuclear power. It is worth noting that all point estimates of the effects of persuasive messages on nuclear-weapons attitudes were negative.[42] The confirmatory trial will clarify whether these results hold in a higher-powered and representative sample. Even if Japanese political elites do not share such attitudinal predispositions with the broader populace, constituent attitudes likely represent a salient constraint on their preferred policies. It would be extremely costly for Japanese policymakers to persuade the public to accept nuclear armament, let alone to bypass the electorate altogether.

Japan's experience with both nuclear power and nuclear weapons is unique, and we cannot reasonably generalize these results to other states that may represent proliferation risks. Nonetheless, the comparison explored here highlights Japan's importance as a case for future research on nuclear attitudes. In particular, the separation between attitudes toward nuclear power and those toward nuclear weapons reveals a potential path for promoting the peaceful use of nuclear power without increasing the risk of proliferation. As nuclear power is often promoted as both an efficient and carbon-neutral energy source, such potential is especially salient given the pressures posed by climate change in an increasingly industrialized world. This is not to say that promoting nuclear power in itself is desirable. As the 2011 Fukushima disaster demonstrates, nuclear power is not without severe risks even apart from the possibility of proliferation. Nonetheless, as countries and mass publics continue to weigh the utility of peaceful nuclear energy, it will remain critical to assure that the technology's future remains proliferation-free. To the extent that lessons learned in Japan may promote such an outcome, in keeping with the spirit of the Non-Proliferation Treaty, policymakers and academics alike should continue to pay close attention to this particular case.

[41] It has been argued that this achievement owes, as well, to decades of strong government control over anti-nuclear messaging and protests (Aldrich, 2010; Jones et al., 2013).

[42] While the point estimate of the effect of pro-nuclear weapon messaging on nuclear-power attitudes was positive, I show that Japanese attitudes toward nuclear weapons are unlikely to grow more positive, even in the face of strong persuasive messaging. More to the point, the influence of pro-nuclear weapons attitudes on nuclear-power attitudes is irrelevant to discussions regarding the proliferation risks posed by Japan's commercial nuclear industry.

References

Aldrich, D. P. (2010). *Site fights: Divisive facilities and civil society in Japan and the West*. Cornell University Press.

Baron, J. (2016, July). Author Interview.

Baron, J. (2019). factorial-assign JavaScript package version 1.0.1.

Baron, J. (2020). *Mass Attitudes and the Relationship Between Nuclear Power and Nuclear Weapons*. Ph. D. thesis, Yale University.

Baron, J. and S. Herzog (2020). Public opinion on nuclear energy and nuclear weapons: The attitudinal nexus in the united states. *Energy Research & Social Science 68*, 101567.

Baumgartner, F. R. and B. D. Jones (1993 [2009]). *Agendas and instability in American politics*. University of Chicago Press.

Behrens, J. (1997, 06). Principles and Procedures of Exploratory Data Analysis. *Psychological Methods 2*, 131–160.

Berinsky, A. J., G. A. Huber, and G. S. Lenz (2012). Evaluating Online Labor Markets for Experimental Research: Amazon.com's Mechanical Turk. *Political Analysis 20*(3), 351–368.

Boyer, P. (1985 [2005]). *By the Bomb's Early Light: American Thought and Culture at the Dawn of the Atomic Age*. Chapel Hill, US: University of North Carolina Press.

Bupp, I. C. and J.-C. Derian (1981). *The failed promise of nuclear power: the story of light water*. Basic Books.

Chanlett-Avery, E. and M. B. Nikitin (2009). Japan's Nuclear Future: Policy Debate. *Prospects, and US Interests', Congressional Research Service, RL-34487 19*.

Cheung, J. H., D. K. Burns, R. R. Sinclair, and M. Sliter (2017). Amazon Mechanical Turk in organizational psychology: An evaluation and practical recommendations. *Journal of Business and Psychology 32*(4), 347–361.

Chipman, H. and R. McCulloch (2016). BayesTree: Bayesian additive regression trees. *R package version 0.3-1.4*.

Chipman, H. A., E. I. George, and R. E. McCulloch (2010, 03). BART: Bayesian additive regression trees. *Ann. Appl. Stat. 4*(1), 266–298.

Cohen, L., M. McCubbins, and F. Rosenbluth (1995). The politics of nuclear power in Japan and the United States. In *Structure and Policy in Japan and the United States*, pp. 177–202. Cambridge University Press.

Cohn, S. M. (1997). *Too cheap to meter: an economic and philosophical analysis of the nuclear dream*. SUNY Press.

Converse, P. E. (1964). The Nature of Belief Systems in Mass Publics (1964). *Critical Review 18*(1-3), 1–74.

Coppock, A. and D. P. Green (2017). Do Belief Systems Exhibit Dynamic Constraint?

Crater, H. L. (1977). What Opinions Do High School Students Hold About Nuclear Science? *School Science and Mathematics 77*(6), 495–501.

Croall, S. and K. Sempler (1979). Nuclear power for beginners.

Del Sesto, S. L. (1979). The commercialization of civilian nuclear power and the evolution of opposition: The American experience, 1960–1974. *Technology in Society 1*(4), 301–327.

Del Sesto, S. L. (1983). Uses of knowledge and values in technical controversies: The case of nuclear reactor safety in the US. *Social Studies of Science 13*(3), 395–416.

DellaVigna, S. and M. Gentzkow (2010). Persuasion: Empirical Evidence. *Annual Review of Econmics 2*(1), 643–669.

Downey, G. L. (1986). Risk in Culture: The American Conflict Over Nuclear Power. *Cultural Anthropology 1*(4), 388–412.

Druckman, J. N. (2001). The implications of framing effects for citizen competence. *Political behavior 23*(3), 225–256.

Fabrigar, L. R., J. R. Priester, R. E. Petty, and D. T. Wegener (1998). The Impact of Attitude Accessibility on Elaboration of Persuasive Messages. *Personality and Social Psychology Bulletin 24*(4), 339–352.

Gallup (1948). Gallup Poll #1948-0430: Elections, 1948 [Dataset]. Roper #31087413, Version 2. Gallup Organization [producer]. Cornell University, Ithaca, NY: Roper Center for Public Opinion Research [distributor]. Access Date: Dec-25-2019.

Gallup (1999, June). Gallup Japan Poll on the Ownership of Nuclear Weapons and the Threat of Nuclear War: Japanese doubt nuclear war is likely in the next decade.

Gamson, W. A. and A. Modigliani (1989). Media Discourse and Public Opinion on Nuclear Power: A Constructionist Approach. *American Journal of Sociology 95*(1), 1–37.

Girondi, A. J. (1983). A discriminant analysis of attitudes related to the nuclear power controversy. *The Journal of Environmental Education 14*(4), 2–6.

Green, D. P., P. M. Aronow, D. E. Bergan, P. Greene, C. Paris, and B. I. Weinberger (2011). Does knowledge of constitutional principles increase support for civil liberties? Results from a randomized field experiment. *The Journal of Politics 73*(2), 463–476.

Green, D. P. and H. L. Kern (2012, 09). Modeling Heterogeneous Treatment Effects in Survey Experiments with Bayesian Additive Regression Trees. *Public Opinion Quarterly 76*(3), 491–511.

Haugtvedt, C. P. and D. T. Wegener (1994). Message order effects in persuasion: An attitude strength perspective. *Journal of Consumer Research 21*(1), 205–218.

Hill, J. L. (2011). Bayesian nonparametric modeling for causal inference. *Journal of Computational and Graphical Statistics 20*(1), 217–240.

Huff, C. and D. Tingley (2015). "Who Are These People?" Evaluating the Demographic Characteristics and Political Preferences of MTurk Survey Respondents. *Research & Politics 2*(3), 1–12.

Hughes, L. (2007). Why Japan will not go nuclear (yet): international and domestic constraints on the nuclearization of Japan. *International Security 31*(4), 67–96.

Japan Atomic Industrial Forum (2019, March). 原子力に関する調査　結果報告書. Technical report, Japan Atomic Industrial Forum.

Jones, C. F., S.-L. Loh, and K. Satō (2013). Narrating Fukushima: Scales of a nuclear meltdown. *East Asian Science, Technology and Society: An International Journal 7*(4), 601–623.

Joppke, C. (1993). *Mobilizing Against Nuclear Energy: A Comparison of Germany and the United States*. Berkeley: University of California Press.

Kase, Y. (2001). The costs and benefits of Japan's nuclearization: An insight into the 1968/70 internal report. *The Nonproliferation Review 8*(2), 55–68.

Kasperson, R. E., G. Berk, D. Pijawka, A. B. Sharaf, and J. Wood (1980). Public Opposition to Nuclear Energy: Retrospect and Prospect. *Science, Technology, & Human Values 5*(2), 11–23.

Kasperson, R. E., O. Renn, P. Slovic, H. S. Brown, J. Emel, R. Goble, J. X. Kasperson, and S. Ratick (1988). The Social Amplification of Risk: A Conceptual Framework. *Risk Analysis 8*(2), 177–187.

Kawamura, N. (2007). Emperor Hirohito and Japan's Decision to Go to War with the United States: Reexamined. *Diplomatic History 31*(1), 51–79.

Kelly, D. (2014). US Hegemony and the Origins of Japanese Nuclear Power: The Politics of Consent. *New Political Economy 19*(6), 819–846.

Kim, S. C. (2017). Endangering alliance or risking proliferation?: US–Japan and US–Korea nuclear energy cooperation agreements. *The Pacific Review 30*(5), 692–709.

Kitada, A. (2016). Public opinion changes after the Fukushima Daiichi Nuclear Power Plant accident to nuclear power generation as seen in continuous polls over the past 30 years. *Journal of Nuclear Science and Technology 53*(11), 1686–1700.

Kotler, M. L. and I. T. Hillman (2000). Japanese nuclear energy policy and public opinion.

Kranzberg, M. (1980). Prospects for Change. In R. C. Schwing and W. A. Albers (Eds.), *Societal Risk Assessment: How Safe is Safe Enough?*, pp. 319–332. New York: Springer. Proceedings of an international symposium held Oct. 8-9, 1979 at the General Motors Research Laboratories, Warren, MI and sponsored by the Laboratories.

Kurosaki, A. (2017). Nuclear energy and nuclear-weapon potential: A historical analysis of Japan in the 1960s. *The Nonproliferation Review 24*(1-2), 47–65.

Kuznick, P. (2011). Japan's nuclear history in perspective: Eisenhower and atoms for war and peace. *Bulletin of the Atomic Scientists 13*.

Levay, K. E., J. Freese, and J. N. Druckman (2016). The demographic and political composition of Mechanical Turk samples. *Sage Open 6*(1), 2158244016636433.

Lin, W. and D. P. Green (2016). Standard Operating Procedures: A Safety Net for Pre-Analysis Plans. *PS: Political Science & Politics 49*(3), 495–500.

Mazur, A. (1973). Disputes Between Experts. *Minerva 11*(2), 243–262.

Mazur, A. (1981). *The Dynamics of Technical Controversy*. Washington, DC: Communications Press.

Mazur, A. (1990). Nuclear power, chemical hazards, and the quantity of reporting. *Minerva*, 294–323.

McCormack, G. et al. (2007). Japan as a plutonium superpower. *Japan Focus 9*.

Medhurst, M. J. (1997). Atoms for peace and nuclear hegemony: The rhetorical structure of a Cold War campaign. *Armed Forces & Society 23*(4), 571–593.

Mochizuki, M. M. (2007). Japan tests the nuclear taboo. *Nonproliferation Review 14*(2), 303–328.

Morris-Suzuki, T. (1994). *The technological transformation of Japan: From the seventeenth to the twenty-first century*. Cambridge University Press.

Nelson, C. (2011). 'The energy of a bright tomorrow': the rise of nuclear power in Japan. *Origins 4*(9).

Offer-Westort, M., A. Coppock, and D. P. Green (2019). Adaptive Experimental Design: Prospects and Applications in Political Science. *Available at SSRN 3364402*.

Olken, B. A. (2015, September). Promises and Perils of Pre-analysis Plans. *Journal of Economic Perspectives 29*(3), 61–80.

Otway, H. J., D. Maurer, and K. Thomas (1978). Nuclear Power: The Question of Public Acceptance. *Futures 10*(2), 109–118.

Pahner, P. D. (1976). A Psychological Perspective of the Nuclear Energy Controversy. Technical Report RM-76-67, International Institute for Applied Systems Analysis, Laxenburg, Austria. http://pure.iiasa.ac.at/id/eprint/617/1/RM-76-067.pdf. Retrieved July 16, 2019.

Pew Research Center (2012). As Gas Prices Pinch, Support for Oil and Gas Production Grows. March 19. http://www.pewresearch.org/wp-content/uploads/sites/4/legacy-pdf/3-19-12-Energy-release.pdf. Retrieved July 9, 2019.

Rankin, W. L., B. D. Melber, T. D. Overcast, and S. M. Nealey (1981). Nuclear Power and the Public: An Update of Collected Survey Research on Nuclear Power. Technical report, Battelle Human Affairs Research Center, Seattle. PNL-4048. December. https://www.osti.gov/servlets/purl/5271934. Retrieved July 16, 2019.

Reinhart, R. (2019, March). 40 Years After Three Mile Island, Americans Split on Nuclear Power. https://news.gallup.com/poll/248048/years-three-mile-island-americans-split-nuclear-power.aspx. Retrieved February 5, 2020.

Riffkin, R. (2016, March). For First Time, Majority in U.S. Oppose Nuclear Energy. http://www.gallup.com/poll/190064/first-time-majority-oppose-nuclear-energy.aspx. Retrieved July 9, 2019.

Roper (1957). Roper Commercial # 1957-103: Views on Current Events, 1957 [Dataset]. Roper #31097105, Version 2. The Roper Organization [producer]. Cornell University, Ithaca, NY: Roper Center for Public Opinion Research [distributor]. Access Date: Dec-25-2019.

Rosentiel, T. (2010, April). Nuclear Reaction.

Samuels, R. J. (1987). *The business of the Japanese state*. Cornell University Press Ithaca.

Showers, D. E. and R. L. Shrigley (1995). Effects of knowledge and persuasion on high-school students' attitudes toward nuclear power plants. *Journal of Research in Science Teaching 32*(1), 29–43.

Slovic, P. (1987). Perception of Risk. *Science 236*(4799), 280–285.

Slovic, P., B. Fischhoff, and S. Lichtenstein (1976). Cognitive processes and societal risk taking. In *Decision making and change in human affairs*, pp. 7–36. Springer.

Stebbins, R. A. (2001). *Exploratory Research in the Social Sciences*, Volume 48. Sage.

Takekawa, S. (2012). Drawing A Line Between Peaceful and Military Uses of Nuclear Power: The Japanese Press, 1945-1955. *ASIA-PACIFIC JOURNAL-JAPAN FOCUS 10*(37).

Tamplin, A. R. and Gofman (1970). "Population control" through nuclear pollution.

The Genron NPO (2017). Poll 2017 annual public opinion report: The future of northeast asia and the state of democracy. Technical report, The Genron NPO.

Tukey, J. W. (1977). Exploratory data analysis. *Reading, Ma 231 32*.

Tukey, J. W. (1980). We need both exploratory and confirmatory. *The American Statistician 34*(1), 23–25.

Van Der Pligt, J., J. R. Eiser, and R. Spears (1986). Attitudes Toward Nuclear Energy: Familiarity and Salience. *Environment and Behavior 18*(1), 75–93.

Wagenmakers, E.-J., R. Wetzels, D. Borsboom, H. L. van der Maas, and R. A. Kievit (2012). An agenda for purely confirmatory research. *Perspectives on Psychological Science 7*(6), 632–638.

Weart, S. R. (1988). *Nuclear Fear: A History of Images*. Cambridge, US: Harvard University Press.

Weart, S. R. (2012). *The Rise of Nuclear Fear*. Cambridge, US: Harvard University Press.

Wittneben, B. B. (2012). The impact of the Fukushima nuclear accident on European energy policy. *Environmental Science & Policy 15*(1), 1–3.

World Nuclear Association (2019). Nuclear Power in the World Today. February; https://www.world-nuclear.org/information-library/current-and-future-generation/nuclear-power-in-the-world-today.aspx. Retrieved July 16, 2019.

Yamada, K. (2019, March). JAERO's Recent Public Opinion Survey on Nuclear Energy: Support Rises Somewhat for Restarting NPPs. *Atoms in Japan*.

Yergin, D. (1991, December). Blood and Oil: Why Japan Attacked Pearl. *The Washington Post*.

Zaller, J. R. (1992). *The Nature and Origins of Mass Opinion*. Cambridge University Press, Cambridge.

Zwigenberg, R. (2012). "The Coming of a Second Sun": The 1956 Atoms for Peace Exhibit in Hiroshima and Japan's Embrace of Nuclear Power. *ASIA-PACIFIC JOURNAL-JAPAN FOCUS 10*(6).

A Treatments

A.0.1 Pro-Power Treatment

Environmental Radiation
Contrary to popular belief, nuclear power poses little health risk from radiation. We are constantly exposed to natural radiation—from the ground, from cosmic rays, and even from the food we eat. In fact, a person living within 50 miles of a nuclear power plant for a year is exposed to less radiation than they would get from eating a banana, which naturally contains radioactive potassium. All the nuclear power plants in the world emit only a fraction of the natural environmental radiation that people are exposed to. A typical nuclear power plant in the United States doesn't

even release enough radiation to cause one cancer death per year.

一般的なイメージに反して、原子力発電所の放射線による健康被害は微々たるものです。人は常に地上、宇宙、さらには食品に含まれる自然放射線に日々晒されています。事実、原子力発電所80km圏内で生活する住民の受ける年間被曝量は、バナナ1本の放射性カリウム含有量より少ないのです。従って、世界中の原子力発電所が発する放射線量は、人間の受ける自然放射線量のほんの一部にも満たないと言えます。アメリカの原子力発電所が1年に放出する放射線量は、1人の人が癌になる被曝量にも達しません。

Waste and environment

Nuclear power generates remarkably little waste. Nuclear plants emit zero carbon waste. Even with uranium mining, nuclear is an exceptionally clean energy source. As a result, experts have often cited nuclear energy as the only viable solution to climate change. Nuclear waste could be dangerous if stored unsafely, but it is no more harmful than other toxic industrial wastes. In fact, nuclear waste can be stored safely above ground for decades, and for thousands of years underground, without any risk of toxic leaks. Nuclear materials have existed naturally in the earth's crust for millions of years, without harming humans.

原子力発電所から発生する廃棄物は驚くほど少ないです。全く二酸化炭素が発生しませんし、ウランの使用を鑑みてもクリーンエネルギーの代表格なのです。この点から、専門家の多くも原子力発電が地球温暖化や気候変動に対する唯一の現実的な解決策だと考えています。放射性廃棄物は適切に保管されなければ危険になり得ますが、その危険度は他の有害産業廃棄物と同程度です。また、放射性廃棄物を地上に何十年、そして地下に何千年も漏れ無しに安全に保管することは十分可能です。放射性物質は何百万年もの間、人類を傷つけることなく地球に自然に存在しているのですから。

Accidents

There is at most a 1 in 10,000 chance of a major nuclear accident occurring somewhere in the world each year. Modern nuclear plants use several layers of defenses and redundancies to stop accidents from affecting members of the public. The United States has a particularly good safety record. A nuclear accident absolutely does not mean a catastrophe. Chernobyl, the worst nuclear accident in history, caused fewer deaths than the number of people wh o die in car accidents in the United States in a typical year. Most of these deaths (and the accident itself) could have been avoided with better government control. Experts have noted that the Fukushima nuclear disaster was caused by a highly unusual tsunami. Even so, it caused zero deaths in the public and will not cause any in the future. New nuclear reactor designs are even safer. Even without human intervention, new passive safety features make accidents like Chernoybl and Fukushima physically impossible. Nuclear power plants are also designed to withstand terrorist attacks and most natural disasters.

ある年に原子力発電所が大きな事故を起こす可能性は、全世界を合わせても1万分の1です。さらに、例え事故が発生したとしても、現代技術による何層もの防御システ

ムや原子炉の多重障壁が放射性物質が近隣住民まで到達するのを防ぎます。原子力発電所の事故が全て大災害に繋がるわけではないのです。史上最悪の原子力事故と言われるチェルノブイリ発電所の事故による死亡者でさえ、日本での不慮の事故による年間死亡者数より少なく、またこの事故による死者のほとんど(事故そのものも)は政府がよりよく対応していれば避けられました。専門家によれば、福島原子力発電所の事故は未曾有の津波によるものですが、それでもこの事故による一般人の死者は0人で、それは今後も変わりません。新たに開発された原子炉はさらに安全で、安全装置が人による制御無しに、チェルノブイリや福島のような事故の発生を物理的に不可能にします。また、原子力発電所はテロ攻撃やほとんどの自然災害に耐え得る構造になっています。

Economics and Efficiency
Nuclear power is extremely efficient. It uses very little fuel compared to how much electricity it can generate. The cost that consumers pay for nuclear-generated electricity factors in all other cost considerations. Nuclear power is actually the only energy source that includes all of these costs, yet it is still very affordable to consumers. The efficiency of nuclear power means it also is great for industry and business, since it can provide so much electricity at such a low cost. More research into uranium sources and mining could make nuclear power even more efficient and cheaper. Nuclear power also provides energy security—because it is so efficient, it necessitates very little importation of overseas resources.

原子力による発電は大変効率的です。発電量に比べごく少量の燃料しか必要としません。原子力発電は、消費者による電気代の支払いで全てのコストをまかなう唯一の発電方法ですが、それでも電気代は高くありません。さらにこの効率性は、工業やビジネスにおいても電力消費によるコストを大幅に削減できることを意味します。今後ウランの使用や採掘に関する研究が進めば、さらに効率は上がりコストを削減することができるでしょう。また、効率性により、外国資源に頼る必要もほとんどなく、エネルギー保障にもつながります。日本の電気料金は原子力発電により大幅に安くなるのです。

A.0.2 Anti-Power Treatment

Environmental Radiation

Natural radiation exists all around us, but nuclear power plants expose the public to excess radiation each day. Nuclear power adds an unnecessary, unnatural source of radiation into our environment, posing serious health risks. While natural environmental radiation can cause cancer, people living close to nuclear power plants are exposed to higher doses of radiation—the closer a person lives to a plant, the greater their exposure. A typical nuclear power plant in the United States releases enough radiation to cause around one cancer death per year that would otherwise be avoided.

自然放射線は身の回りに存在しますが、原子力発電により私たちは日々必要以上に被曝することになります。人工的な放射能源は不必要な健康リスクをもたらすのです。自然放射線も癌の原因になり得ますが、原子力発電所付近に住む人々は更に高い被曝量を受け、その度合いは発電所に近いほど増加します。日本の原子力発電所一基から発生する放射線量は２年間で1人の人を癌により死亡させる量に匹敵しますが、これは発電所さえなければ防げるのです。六ヶ所村核燃料再処理施設でのウラン再利用過程で発生する放射線量は、1年に近隣住民130人を癌による死に追いやることのできる量です。

Waste and environment

Nuclear power plants literally produce tons of waste. A typical nuclear power plant requires hundreds of tons of mined uranium. There are currently over 70,000 tons of waste from nuclear plants in the United States. Nuclear waste can remain toxic for millions of years. Scientists claim that this toxic waste can be safely stored underground, but tests of these technologies have failed due to leaks of contaminated wastes. In the meantime, most nuclear waste is stored at nuclear power plants, often out in the open. This short-term storage is dangerous, but long-term storage would be even more so, since it would eventually leak into the surrounding environment and ground water, harming anyone living nearby.

原子力発電は計り知れない量の廃棄物を生成します。発電には何百トンものウランが必要で、結果現在日本には1万8千トンを超える原子力発電による放射性廃棄物が存在します。この廃棄物は何百万年もの間有毒性を失いません。科学者たちは、廃棄物を地下で安全に保管できると主張しますが、保管技術の実験は汚染物質の漏れが確認され失敗に終わっています。そして現在、ほとんどの放射性廃棄物は発電所付近で野外に保管されています。この短期の保管方法も危険ですが、地下での長期保管には汚染物質が周囲の土壌や地下水に広まり莫大な健康被害をもたらす可能性もあり、大変危険です。

Accidents

Claims that nuclear power is safe from accidents are a myth. Small accidents happen at nuclear plants with alarming frequency. And, there have been several major nuclear accidents over the history of nuclear power. Some of the most severe accidents occurred in the United States. These events have shown failures in defenses and redundancies that advocates claim make nuclear power plants safe. Some of these defenses, like coolant systems, are unreliable even during normal operation, and total failure can cause hydrogen explosions that lead to massive releases of toxic materials. This is what happened in the Three Miles Island accident in Pennsylvania, and more recently in Fukushima. Chernobyl, the worst nuclear accident in history, is estimated to have caused 30,000 - 500,000 deaths.

原子力発電は事故を起こさず安全、というのは神話に過ぎません。発電所での小さな事故は高頻度で起きており、いくつかの大事故も国内外で発生しました。防御システムや原子炉の多重障壁が事故を防ぐ、という安全神話は間違いであることが十分証明されているのです。こういった防御システムの一部、例えば冷却水の機能は、通常稼働時でさえも信頼できるものではなく、大事故の際には水蒸気爆発を起こし大量の汚染物質を放出する可能性があります。これは実際福島原子力発電所の事故の際に起きたことです。史上最悪の原子力事故と言われるチェルノブイリ発電所の事故は3万～5万人の死者を出したと言われています。

Economics and Efficiency

Nuclear power is full of hidden costs that make it unreasonably expensive. Nuclear power plants almost always suffer from severe cost overruns and delays in construction, and these costs are passed on to the consumer. Mined uranium reserves are limited, and could grow more expensive over time, while methods for recycling nuclear fuel are excessively overpriced. Nuclear power also supports excessive government control and centralized big business, even though smaller-scale, decentralized power generation methods could be used more efficiently and cheaply by consumers throughout the United States. As it stands, nuclear power is probably the most expensive source of electricity in the United States.

原子力発電には隠れたコストが多くあり、電気料金は大変高価になります。発電所建設には多くの場合予定を超える費用と時間がかかり、そのコストは消費者が負担することとなります。採掘済みのウラン量は限られており、今後さらに高額化する恐れがある一方、核燃料の再利用技術には過度な利用料が設定されています。また、原子力発電には政府及び大規模な電力会社の管理が必要不可欠ですが、民間による小規模の発電方式の方が効率的であり、安価な電力を提供することができます。政府による助成金や諸々のコストを鑑みれば、原子力は歌われているほど安価な発電方式ではないのです。

A.0.3 Pro-Weapon Treatment

Deterrence

Contrary to popular belief, many experts agree that nuclear weapons in the hands of a few responsible countries make the world safer and more peaceful. This is because nuclear weapons are so destructive that no country would want to use them, for fear of inviting retaliation. Countries like the United States have nuclear weapons that can be launched even after a full-scale nuclear strike from an enemy. As a result, any attacker could be destroyed, even after it attacks first. These mutual threats keep countries from attacking each other even with non-nuclear weapons. As a result, the world has been a safer place, with less war since the invention of nuclear weapons. In fact, many experts believe that nuclear weapons are the main reason why the United States and Russia did not go to war after World War II.

一般的なイメージに反して、多くの専門家は、責任ある少数の国家が核兵器を所有した方が世界は安全で平和になると考えています。核兵器は凄まじい破壊力を有するため、どの国も報復攻撃を恐れ使用しようとはしないからです。アメリカや中国はたとえ敵から核攻撃を受けたとしても核兵器を使用できるシステムを備えているので、敵国は先制攻撃を加えたとしても報復され破壊されてしまうのです。この抑止力により、国々は核兵器使用の有無に関わらず他国への攻撃を避け、結果核兵器の開発以降戦争の数は減少し世界はより平和になりました。事実、専門家たちは核兵器こそが第二次世界大戦後米国とロシアによる戦争が勃発しなかった大きな理由だと考えています。

Safety and accidents

Existing nuclear weapons can be stored and maintained safely. In the United States, bombs are also designed to be safe against accidental nuclear explosions. Even if a nuclear weapon were shot with a gun, dropped out of an airplane by accident, or attacked with a normal bomb, this would not trigger a nuclear explosion. The non-nuclear components of American bombs are also tested every year to make sure they are safe and work properly. Today's nuclear weapons are also less destructive than they once were. The destructive yields on weapons have come down since the Cold War. During the Cold War, the US stockpile reached over 30,000 warheads. That number is now closer to 6,500. This reduction reduces any chances of accidents, but does not make nuclear weapons less effective.

核兵器は安全に保管されています。アメリカの核爆弾は、事故により核爆発が起きないよう設計されており、銃で撃たれたり、戦闘機より落下してしまったり、通常の爆弾で攻撃されたりしても核融合に至らないようになっています。また、非核爆弾に対しても毎年安全性と機能性の試験が行われています。核爆弾の数は冷戦期以降減少しています。冷戦時3万を超えたアメリカの核弾頭保有数は現在6500に迫るまで減少し、事故の可能性はより薄れた一方、核兵器の機能性自体は変化していません。

Environment

Nuclear weapons were initially tested in the atmosphere and underground, but this is no longer the case. The United States has not conducted atmospheric tests since 1962, and it has not conducted underground tests since 1992. American scientists can now use computer simulations to assess the reliability of US nuclear weapons with greater confidence than a test in any environment would give them. This means that the United States is very unlikely to test weapons in the atmosphere or underground again. Fallout from these past tests is also not something to be concerned about, as natural radiation is all around us anyway. Although there have been issues of contamination at former nuclear-weapons production sites, such as the Hanford Site in Washington, the government has made major efforts to clean up these sites.

核実験は以前は大気圏内及び地下で行われていましたが、現在は違います。アメリカは1962年以降大気圏内実験を、1992年以降地下実験を行なっていません。アメリカの科学者はコンピュータシミュレーションを用いることにより、核兵器の威力をどのような環境下における実験よりも信頼度の高い精度で評価することができるのです。つまり、アメリカが今後大気圏内及び地下核実験を実施する可能性は極めて低いと言えるでしょう。さらに、実験の放射性降下物に関しても、自然放射線がすでに大量に存在することを考えれば心配には及びません。過去には核実験跡の汚染が問題になりましたが、政府の活動により除染されました。

Proliferation

It is difficult for rogue states to attain enough nuclear materials to make bombs because of the high level of security required, technical difficulties, and costs involved in production. It would be even more difficult for terrorists to attain these materials. A large amount of radioactive materials are required to build even a single nuclear device, so it would be very difficult to produce or obtain these materials without being noticed. The US intelligence community is extremely careful about monitoring these materials. The US government is also constantly working to maintain security against terrorists who may want to steal or use nuclear materials. US nuclear weapons are locked with electronic passcodes that prevent their unauthorized use. The US government takes extreme care in vetting people who work with nuclear arms. The United States also works with a massive international effort to protect these materials from getting into the wrong hands. These efforts include thorough inspections of nuclear sites and work to stop countries or groups that want to proliferate. If the international community catches attempts to proliferate, prompt military action can be used.

テロ支援国家が原料を調達し核兵器を製造する可能性は、機密保持、技術的困難、製造コストを鑑みれば大変低いと考えられます。テロリストによる核兵器製造の可能性はさらに低いでしょう。核爆弾一個を製造するにも大量の原材料が必要となるため、国際社会の目をかいくぐり製造することは大変困難なのです。日本政府は核兵器不拡散に積極的に参画しており、国際機関に協力し核兵器製造に関係する物質の監視を行なっています。米国政府もテロリストによる核物質の持ち出しや使用を防止しており、核兵器を全て電子パスワードで保護することで非権限者による使用を防ぎ、また核兵器製造に関わる作業員に関しては厳格な審査を行なっています。さらに、米国は国際社会を代表し、核開発現場の包括的な調査や非核保有国家・団体の核開発の制限を実施し、核が悪の手に渡らないよう努力をしています。仮に国際機関により核非拡散の抵触が疑われた

場合には、実力行使も可能となります。

A.0.4 Anti-Weapon Treatment

Deterrence

As long as nuclear weapons exist, even in the hands of a few countries, we are all in grave danger of being wiped out completely. The United States used nuclear weapons in World War II, and has considered using them in combat in many other conflicts, including as recently as the 1990s. Even a single use of nuclear weapons could lead to a global nuclear war that would change life as we know it. Since the US nuclear arsenal can survive large-scale attacks, some claim that no enemy would think to attack America or its allies. Even if that is true, there were several occasions during the Cold War when nuclear weapons were almost launched, including by the United States and the USSR. Even one such accidental launch could result in large-scale nuclear war. Plus, countries can still try to use nuclear weapons to destroy all of their adversaries' retaliatory forces. If nuclear war did break out, it would have the potential to end all human life.

核兵器が存在する限り、例え限られた国々のみが保有するとしても、我々はいつ消滅してもおかしくない危険にさらされています。第二次世界大戦中アメリカは2回にわたり日本に対し核兵器を使用し、以後1990年代になっても多くの戦争や紛争において核使用を検討しました。中国と北朝鮮両国も核兵器を所有する今、核兵器一個の使用が世界核戦争を引き起こし我々の生活を完全に変えてしまう可能性は十分にあります。アメリカの核兵器貯蔵量は他国からの核攻撃に耐えられるため、どのような敵であってもアメリカや日本を攻撃しようとはしないと主張する人もいますが、例えそれが本当であったとしても、冷戦中アメリカやソ連が核兵器使用の一歩手前まで行った場面は何度かあったというのも事実です。そのような一度の核兵器使用は大規模な核戦争になり得ます。また、核兵器により敵国の報復力を崩壊させることも可能であり、仮に核戦争が勃発すれば人類が滅亡する可能性もあるのです。

Safety and accidents

Nuclear weapons are dangerous to store, yet are not properly maintained. American bombs are designed to be safe against unauthorized or accidental use, but the technologies used to build and protect nuclear weapons are also decades out of date. The nuclear components of US bombs have not been tested since the early 1990s. We actually do not even know if our nuclear warheads will work when detonated on purpose, let alone whether they are safe against accidental detonation. Nuclear weapons are still the most destructive weapons in the world, and could potentially destroy all life on the planet. There are still around 6,500 nuclear weapons owned by the United States today, and these weapons are no more accurate than those deployed during the Cold War. The danger of their accidental use is greater than ever.

核兵器の保存には危険が伴いますが、安全に保管されているとは言えないのが現状です。アメリカの核爆弾は非権限者や事故による爆発を防ぐような設計となっていると言われていますが、爆弾の製造及び保護に使用されている技術は何十年も前のもので、爆弾の核の部分は1990年代初期以降テストされていません。事故に対し安全であるか、さらには実際に使用しなければならなくなった際機能するか、保証がないのです。それでも、核兵器は世界で最も破壊力のある兵器で、地球上すべての生物を壊滅させる可能

性を秘めています。アメリカは現在も6500の核兵器を所有しており、その安全性が冷戦期より変わっていないことを鑑みれば、事故による爆発の危険性は一段と高いのです。

Environment

Almost 530 nuclear weapons have been tested in the atmosphere, many of them by the United States. The fallout from these tests has released so much radiation into the environment that it still causes cancer deaths to this day. A number of these tests were even carried out in the United States. Most countries in the world are signatories of the Comprehensive Test Ban Treaty, which bans all nuclear explosions in all environments. The United States has signed, but over 20 years later, it still hasn't ratified the treaty. This means the United States could ostensibly test weapons in the atmosphere at any time. Nuclear-weapons production also has had serious consequences for the environment. Enriching nuclear materials to be usable in weapons created an immense amount of waste. As a result, nuclear-weapons sites have led to environmental contamination in the United States. The Hanford Site in Washington, for instance, is the most contaminated site in the United States. As of 2013, there were still radioactive leaks into the soil and water there.

530回に及ぶ核実験が大気圏内で行われてきました。その多くはアメリカが実施したものですが、実験による放射性降下物は未だに環境に害を及ぼし、特に太平洋域において癌による死者を出しています。過去にはアメリカの核実験により日本の漁船が被曝し、結果乗組員1人が死亡しました。世界のほとんどの国が、いかなる環境下におけるいかなる核爆発も禁じる包括的核実験禁止条約に署名しており、アメリカも例外ではありませんが、20年以上にわたり条約に批准してはいません。また、この条約は北朝鮮による度重なる核実験を止めることができていません。核兵器製造による環境への影響は深刻です。核兵器製造の際に必要となる核物質濃縮の過程において大量の廃棄物が排出するため、アメリカや太平洋域では未だに冷戦期の大気圏内核実験による放射性物質が水中に存在し、環境汚染を引き起こしています。

Proliferation

If they are determined enough, rogue states could attain enough nuclear materials to make bombs, despite the high level of security required, technical difficulties, and costs involved in production. Throughout history, multiple states have obtained nuclear weapons despite strong US efforts to stop them. The United States has also failed to detect clandestine efforts to trade nuclear materials and technologies. This is despite considerable efforts on the part of the United States to constantly monitor these potential flows. In fact, rogue states or terrorists could even steal unprotected nuclear arms from the United States. In 2007, several nuclear warheads were accidentally loaded onto a US Air Force bomber and left out in the open on the tarmac for a day and a half. This was despite numerous security precautions. Today, even more countries seem to want nuclear weapons. This could overwhelm international efforts to keep nuclear materials away from rogue states and terrorists. If more countries get nuclear weapons, the risk of a nuclear war will grow exponentially larger. These states could even sell their nuclear materials to terrorists. And, it will be extremely difficult for the United States to stop those states or terrorist groups with military action. US nuclear arms do not keep us safe, but merely pose a risk for dangerous proliferation.

テロ支援国家が十分な材料を手に入れ核爆弾を製造することは、例え機密情報管理や技術的な難しさ、製造コストの高さを鑑みても可能です。歴史的に見ても、複数の国がアメリカの阻止を振り切り核兵器の開発に成功してきました。また、アメリカは継続的な監視を敢行しているにも関わらず、核原料や核技術の機密取引の検知に失敗しています。事実、テロ支援国家やテロリストがアメリカから無防備な状態で核武器を盗み出してしまう可能性もあるのです。2007年には、何重もの安全対策にも関わらず、核弾頭数個が誤って米空軍の爆撃機に搭載され、駐機場に1日半放置されました。今日、さらに多くの国が核兵器を手に入れたがっており、テロ支援国家及びテロリストに核兵器を渡さないという国際的な取り組みに綻びが生じてしまうかもしれません。もし今以上に多くの国が核兵器を所持すれば、核戦争のリスクは飛躍的に高まりますし、これらの国が核をテロリストに売りさばく可能性も出てきます。そうなれば、アメリカが武力行使によってこれらの国やテロリストを止めるのはとても困難になるでしょう。アメリカの核兵器は我々を守ってはくれません。逆に、危険な核拡散のリスクを高めるだけなのです。

A.0.5 Nuclear Placebo

Atoms
The idea that all matter is composed of tiny elements invisible to the naked eye has existed since the times of ancient Greece and India. However, the modern concept of the atom, and the study of physics and chemistry that build on these ideas, is not even 200 years old. The word ”atom” actually comes from ancient Greek. However, the first experimental investigations into atoms began in the 1800s, when John Dalton started theorizing about reactions between different elements.

Electrons
It was not until later in the 1800s, well after the discovery of the atom, that physicist J. J. Thompson discovered the negatively charged electron. These electrons were soon found to be the same particles that carry electricity through wires. This innovative work won Thompson the Nobel Prize in Physics in 1906. This discovery was not only important to future science in the fields of physics, chemistry, and engineering. Thompson’s work also proved that atoms were not the smallest unit of matter in the universe.

Nuclear Physics
The field of nuclear physics arose in 1896 when Henri Becquerel discovered radioactivity. In 1909, physicists discovered the nucleus of the atom. With electrons and the nucleus having been researched in the lab, some scientists turned their attention toward the development of theoretical models of atoms. The first of these models were proposed by Ernest Rutherford and Niels Bohr in 1911 and 1913, respectively. Their models both conceptualized a small, dense nucleus full of positively charged protons, surrounded by negatively charged electrons. As time went on, other scientists around the world, including Marie and Pierre Curie and Becquerel, realized other phenomena around atoms. These included radioactive decay, in which an atom’s nucleus disintegrated, causing that element to ”transmute” into other elements. The first laboratory evidence of this phenomenon was observed in 1917.

Nuclear Reactions
In 1916, chemists realized that chemical reactions were the result of chemical bonds between atoms. In 1932, scientists used protons to split the nucleus of a lithium atom, in an experiment that eventually won the Nobel Prize in Physics. The neutron was discovered that same year. By 1934, Enrico Fermi was working with colleagues on bombarding heavy elements with neutrons. This work soon earned him a Nobel Prize. Around this time, physicist Leó Szilárd had begun thinking about the possibility of a reaction in which neutrons could cause heavy atoms to fission, producing more neutrons, and more fissions. The nuclear reaction was achieved in the lab in 1932, while the first sustained nuclear chain reaction was achieved in late 1942.

B Study 1 Survey First-Order Treatment Effect Estimates

Model specifications are described in Section 5.2.

Table 16: US Study 1 Regression Coefficients of First-Order Treatments (Index Outcomes)

	Model Specification					
Outcome	(1)	(2)	(3)	(4)	(5)	(6)
Power Index						
Pro-Power	0.530	0.429	0.364	0.459	0.412	0.362
	(0.221)	(0.218)	(0.218)	(0.215)	(0.216)	(0.210)
Pro-Weapon	0.229	0.272	0.242	0.289	0.267	0.226
	(0.224)	(0.224)	(0.225)	(0.229)	(0.222)	(0.226)
Anti-Power	–0.331	–0.427	–0.475	–0.404	–0.448	–0.467
	(0.245)	(0.238)	(0.239)	(0.239)	(0.236)	(0.235)
Anti-Weapon	0.049	0.044	0.077	0.041	0.022	0.044
	(0.258)	(0.242)	(0.242)	(0.240)	(0.240)	(0.237)
Weapon Index						
Pro-Power	0.289	0.154	0.135	0.173	0.138	0.140
	(0.228)	(0.212)	(0.210)	(0.214)	(0.203)	(0.203)
Pro-Weapon	0.252	0.276	0.286	0.300	0.260	0.279
	(0.217)	(0.209)	(0.205)	(0.211)	(0.204)	(0.200)
Anti-Power	–0.019	–0.171	–0.203	–0.159	–0.185	–0.198
	(0.237)	(0.216)	(0.209)	(0.216)	(0.210)	(0.203)
Anti-Weapon	–0.088	–0.127	–0.038	–0.122	–0.156	–0.089
	(0.240)	(0.205)	(0.203)	(0.204)	(0.199)	(0.196)

Model (1) refers to the regressions of each given outcome on the main treatments, plus the pure-control condition. Models (2) – (6) all include demographic controls; Models (3) – (6) respectively add in covariates regarding attitudes toward federal spending variables (Model (3)), attitudes toward science and technology (Model (4)), attitudes toward the environment and climate change (Model (5)), and all covariates included in Models (2) – (5) (Model (6)). Estimated HC2 robust standard errors on each coefficient are presented in parentheses under the corresponding coefficient.

Table 17: Japanese Study 1 Regression Coefficients of First-Order Treatments (Index Outcomes)

	Model Specification	
Outcome	(1)	(2)
Power Index		
Pro-Power	0.525	0.348
	(0.193)	(0.211)
Pro-Weapon	0.179	0.115
	(0.198)	(0.224)
Anti-Power	–0.126	–0.184
	(0.182)	(0.205)
Anti-Weapon	0.164	0.003
	(0.180)	(0.218)
Weapon Index		
Pro-Power	0.345	0.066
	(0.215)	(0.271)
Pro-Weapon	0.066	–0.117
	(0.213)	(0.265)
Anti-Power	–0.283	–0.269
	(0.196)	(0.254)
Anti-Weapon	0.065	0.039
	(0.202)	(0.259)

Model (1) refers to the regressions of each given outcome on the main treatments, plus the pure-control condition. Model (2) includes all demographic controls. Estimated HC2 robust standard errors on each coefficient are presented in parentheses under the corresponding coefficient.

C BART Paragraph Selection Results

C.1 US BART Results

Table 18: Selected Messages (constrained to one paragraph)

Pro-Energy Treatment					
Combined	✓	✗	✗	✗	0.364
Power	✓	✗	✗	✗	0.283
Weapon	✗	✗	✗	✓	0.079
Anti-Energy Treatment					
Combined	✗	✓	✗	✗	−1.081
Power	✗	✓	✗	✗	−0.515
Weapon	✗	✓	✗	✗	−0.528
Pro-Weapon Treatment					
Combined	✓	✗	✗	✗	0.214
Power	✓	✗	✗	✗	0.071
Weapon	✓	✗	✗	✗	0.138
Anti-Weapon Treatment					
Combined	✓	✗	✗	✗	−0.347
Power	✓	✗	✗	✗	−0.147
Weapon	✗	✗	✗	✓	−0.258

Table 19: Selected Messages (constrained to two paragraphs)

Pro-Energy Treatment					
Combined	✓	✗	✗	✓	0.859
Power	✓	✗	✗	✓	0.552
Weapon	✓	✗	✗	✓	0.274
Anti-Energy Treatment					
Combined	✗	✓	✗	✓	−1.279
Power	✗	✓	✗	✓	−0.707
Weapon	✗	✓	✗	✓	−0.554
Pro-Weapon Treatment					
Combined	✓	✗	✓	✗	0.449
Power	✓	✗	✓	✗	0.139
Weapon	✓	✗	✗	✓	0.316
Anti-Weapon Treatment					
Combined	✓	✗	✗	✓	−0.466
Power	✓	✓	✗	✗	−0.258
Weapon	✓	✗	✗	✓	−0.332

Table 20: Selected Messages (constrained to three paragraphs)

Pro-Energy Treatment					
Combined	✓	✓	✗	✓	0.826
Power	✓	✓	✗	✓	0.636
Weapon	✓	✗	✓	✓	0.230
Anti-Energy Treatment					
Combined	✗	✓	✓	✓	−1.197
Power	✗	✓	✓	✓	−0.762
Weapon	✗	✓	✓	✓	−0.439
Pro-Weapon Treatment					
Combined	✓	✗	✓	✓	0.678
Power	✓	✓	✓	✗	0.228
Weapon	✓	✗	✓	✓	0.505
Anti-Weapon Treatment					
Combined	✓	✓	✗	✓	−0.357
Power	✓	✓	✗	✓	−0.101
Weapon	✓	✗	✓	✓	−0.278

Table 21: Selected Messages (constrained to four paragraphs)

Pro-Energy Treatment					
Combined	✓	✓	✓	✓	0.466
Power	✓	✓	✓	✓	0.375
Weapon	✓	✓	✓	✓	0.106
Anti-Energy Treatment					
Combined	✓	✓	✓	✓	−0.674
Power	✓	✓	✓	✓	−0.517
Weapon	✓	✓	✓	✓	−0.193
Pro-Weapon Treatment					
Combined	✓	✓	✓	✓	0.657
Power	✓	✓	✓	✓	0.245
Weapon	✓	✓	✓	✓	0.415
Anti-Weapon Treatment					
Combined	✓	✓	✓	✓	−0.056
Power	✓	✓	✓	✓	0.094
Weapon	✓	✓	✓	✓	−0.167

Table 22: Selected Messages (unconstrained)

Pro-Energy Treatment					
Combined	✓	✗	✗	✓	0.859
Power	✓	✓	✗	✓	0.636
Weapon	✓	✗	✗	✓	0.274
Anti-Energy Treatment					
Combined	✗	✓	✗	✓	−1.279
Power	✗	✓	✓	✓	−0.762
Weapon	✗	✓	✗	✓	−0.554
Pro-Weapon Treatment					
Combined	✓	✗	✓	✓	0.678
Power	✓	✓	✓	✓	0.245
Weapon	✓	✗	✓	✓	0.505
Anti-Weapon Treatment					
Combined	✓	✗	✗	✓	−0.466
Power	✓	✓	✗	✗	−0.258
Weapon	✓	✗	✗	✓	−0.332

C.2 Japanese BART Results

Table 23: Selected Messages (constrained to one paragraph)

Pro-Energy Treatment					
Combined	✓	✗	✗	✗	0.589
Power	✓	✗	✗	✗	0.240
Weapon	✓	✗	✗	✗	0.339
Anti-Energy Treatment					
Combined	✗	✗	✓	✗	−0.930
Power	✗	✗	✓	✗	−0.597
Weapon	✗	✗	✓	✗	−0.318
Pro-Weapon Treatment					
Combined	✗	✗	✓	✗	0.296
Power	✗	✓	✗	✗	0.062
Weapon	✗	✗	✓	✗	0.252
Anti-Weapon Treatment					
Combined	✓	✗	✗	✗	−0.384
Power	✗	✓	✗	✗	−0.238
Weapon	✓	✗	✗	✗	−0.167

Table 24: Selected Messages (constrained to two paragraphs)

Pro-Energy Treatment					
Combined	✓	✗	✗	✓	0.907
Power	✓	✗	✓	✗	0.401
Weapon	✓	✗	✗	✓	0.562
Anti-Energy Treatment					
Combined	✗	✓	✓	✗	−1.274
Power	✗	✓	✓	✗	−0.686
Weapon	✗	✓	✓	✗	−0.579
Pro-Weapon Treatment					
Combined	✗	✓	✓	✗	0.538
Power	✓	✓	✗	✗	0.211
Weapon	✗	✓	✓	✗	0.344
Anti-Weapon Treatment					
Combined	✓	✓	✗	✗	−0.662
Power	✓	✓	✗	✗	−0.343
Weapon	✓	✓	✗	✗	−0.313

Table 25: Selected Messages (constrained to three paragraphs)

Pro-Energy Treatment					
Combined	✓	✗	✓	✓	1.061
Power	✓	✓	✓	✗	0.675
Weapon	✓	✗	✓	✓	0.619
Anti-Energy Treatment					
Combined	✗	✓	✓	✓	−1.114
Power	✗	✓	✓	✓	−0.583
Weapon	✗	✓	✓	✓	−0.517
Pro-Weapon Treatment					
Combined	✓	✓	✓	✗	0.476
Power	✓	✓	✓	✗	0.283
Weapon	✓	✓	✓	✗	0.194
Anti-Weapon Treatment					
Combined	✓	✓	✓	✗	−0.525
Power	✓	✓	✓	✗	−0.375
Weapon	✓	✓	✗	✓	−0.315

Table 26: Selected Messages (constrained to four paragraphs)

Pro-Energy Treatment					
Combined	✓	✓	✓	✓	1.230
Power	✓	✓	✓	✓	0.726
Weapon	✓	✓	✓	✓	0.566
Anti-Energy Treatment					
Combined	✓	✓	✓	✓	−0.718
Power	✓	✓	✓	✓	−0.364
Weapon	✓	✓	✓	✓	−0.347
Pro-Weapon Treatment					
Combined	✓	✓	✓	✓	0.152
Power	✓	✓	✓	✓	0.127
Weapon	✓	✓	✓	✓	0.025
Anti-Weapon Treatment					
Combined	✓	✓	✓	✓	−0.045
Power	✓	✓	✓	✓	0.059
Weapon	✓	✓	✓	✓	−0.103

Table 27: Selected Messages (unconstrained)

Pro-Energy Treatment					
Combined	✓	✓	✓	✓	1.230
Power	✓	✓	✓	✓	0.726
Weapon	✓	✗	✓	✓	0.619
Anti-Energy Treatment					
Combined	✗	✓	✓	✗	−1.274
Power	✗	✓	✓	✗	−0.686
Weapon	✗	✓	✓	✗	−0.579
Pro-Weapon Treatment					
Combined	✗	✓	✓	✗	0.538
Power	✓	✓	✓	✗	0.283
Weapon	✗	✓	✓	✗	0.344
Anti-Weapon Treatment					
Combined	✓	✓	✗	✗	−0.662
Power	✓	✓	✓	✗	−0.375
Weapon	✓	✓	✗	✓	−0.315

D Additional Results

E Pre-Confirmatory Study Power Analysis

Results of power analyses based on the effects estimated in Study 2, Survey 2 are presented below.

Power analyses were performed using five inferential targets: 1.) individual effects of each treatment on each outcome (β_1, β_2, β_3, and β_4 from Model 2.1; and γ_1, γ_2, γ_3, and γ_4 from Model 2.2); 2.) within-domain coefficient differences ($\beta_1 - \beta_2$ and $\beta_3 - \beta_4$ in Model 2.1; and $\gamma_1 - \gamma_2$ and $\gamma_3 - \gamma_4$ in Model 2.2); 3.) the sum of within-domain coefficient differences on out-of-domain outcomes ($(\beta_3 - \beta_4) + (\gamma_1 - \gamma_2)$); 4.) Wald-type tests of the joint significance of within-domain treatments on each outcome; and 5.) seemingly unrelated regressions (SURs) comparing out-of-domain effects from both Model 2.1 and Model 2.2 with a Wald test.[43]

E.1 Power Analysis Results

E.1.1 Individual Effects

Table 28: Full Model

	Treatment			
Power Index				
Simulated N	*Pro-Power*	*Anti-Power*	*Pro-Weapon*	*Anti-Weapon*
2000	0.998	0.998	0.796	0.082
2500	0.999	0.999	0.872	0.093
3000	1.000	0.999	0.920	0.095
Weapon Index				
Simulated N	*Pro-Power*	*Anti-Power*	*Pro-Weapon*	*Anti-Weapon*
2000	0.577	0.595	0.999	0.238
2500	0.664	0.682	1.000	0.269
3000	0.737	0.750	1.000	0.309

[43] SURs are fit in Stata, using data generated in R.

Table 29: Full Model (halved effects)

	Treatment			
Power Index				
Simulated N	*Pro-Power*	*Anti-Power*	*Pro-Weapon*	*Anti-Weapon*
2000	0.746	0.755	0.347	0.063
2500	0.814	0.828	0.397	0.069
3000	0.873	0.885	0.455	0.070
Weapon Index				
Simulated N	*Pro-Power*	*Anti-Power*	*Pro-Weapon*	*Anti-Weapon*
2000	0.233	0.250	0.851	0.118
2500	0.269	0.277	0.912	0.131
3000	0.304	0.320	0.950	0.140

Table 30: Full Model (null effects)

	Treatment			
Power Index				
Simulated N	*Pro-Power*	*Anti-Power*	*Pro-Weapon*	*Anti-Weapon*
2000	0.050	0.050	0.051	0.048
2500	0.052	0.055	0.054	0.050
3000	0.048	0.050	0.051	0.050
Weapon Index				
Simulated N	*Pro-Power*	*Anti-Power*	*Pro-Weapon*	*Anti-Weapon*
2000	0.049	0.052	0.051	0.049
2500	0.051	0.050	0.046	0.053
3000	0.050	0.048	0.050	0.051

E.1.2 Within-Domain Coefficient Differences

Table 31: Coefficient Differences

	Coefficient Difference			
	Power Index		**Weapon Index**	
Simulated N	*Power*	*Weapon*	*Power*	*Weapon*
2000	1.000	0.865	0.979	1.000
2500	1.000	0.928	0.994	1.000
3000	1.000	0.959	0.999	1.000

Table 32: Coefficient Differences (halved effects)

	Coefficient Difference			
	Power Index		**Weapon Index**	
Simulated N	*Power*	*Weapon*	*Power*	*Weapon*
2000	0.999	0.389	0.580	0.935
2500	0.999	0.467	0.676	0.972
3000	1.000	0.516	0.750	0.986

Table 33: Coefficient Differences (null effects)

	Coefficient Difference			
	Power Index		**Weapon Index**	
Simulated N	*Power*	*Weapon*	*Power*	*Weapon*
2000	0.049	0.050	0.051	0.047
2500	0.051	0.049	0.053	0.048
3000	0.051	0.052	0.050	0.050

E.1.3 Summed Differences

Table 34: Power Analysis of Summed Cross-Domain Effects

Simulated N	*Base Specification*	*Halved Effects*	*Null Effects*
$N = 2000$	1.0000	0.9815	0.0489
$N = 2500$	1.0000	0.9942	0.0451
$N = 3000$	1.0000	0.9986	0.0490

E.1.4 Wald Test

Table 35: Coefficient Differences

	Coefficient Difference			
	Power Index		**Weapon Index**	
Simulated N	*Power*	*Weapon*	*Power*	*Weapon*
2000	1.000	0.778	0.924	1.000
2500	1.000	0.876	0.971	1.000
3000	1.000	0.925	0.989	1.000

Table 36: Coefficient Differences (halved effects)

	Coefficient Difference			
	Power Index		**Weapon Index**	
Simulated N	*Power*	*Weapon*	*Power*	*Weapon*
2000	0.990	0.253	0.365	0.875
2500	0.998	0.315	0.448	0.944
3000	0.999	0.373	0.527	0.970

Table 37: Coefficient Differences (null effects)

	Coefficient Difference			
	Power Index		**Weapon Index**	
Simulated N	*Power*	*Weapon*	*Power*	*Weapon*
2000	0.051	0.053	0.052	0.045
2500	0.053	0.052	0.048	0.050
3000	0.051	0.054	0.049	0.050

E.2 Seemingly Unrelated Regressions

Table 38: Power Analysis of Summed Cross-Domain Effects

Simulated N	*Base Specification*
$N = 2000$	0.912
$N = 2500$	0.967
$N = 3000$	0.988