CHAPTER 31

Experiments on Problems of Climate Change

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Abstract

Climate change presents a dire political problem. If we are unable to check carbon emissions, increasing temperatures could produce devastating effects around the globe. Effective global climate action requires international coordination; compliance with an international agreement requires public support of climate policy; and public support of climate policy depends on individuals' climate beliefs. How can experiments shed light on the political challenges involved in addressing climate change? This chapter examines experiments investigating climate beliefs, climate action, and climate coordination, focusing on what we have already learned and where experiments can usefully contribute more.
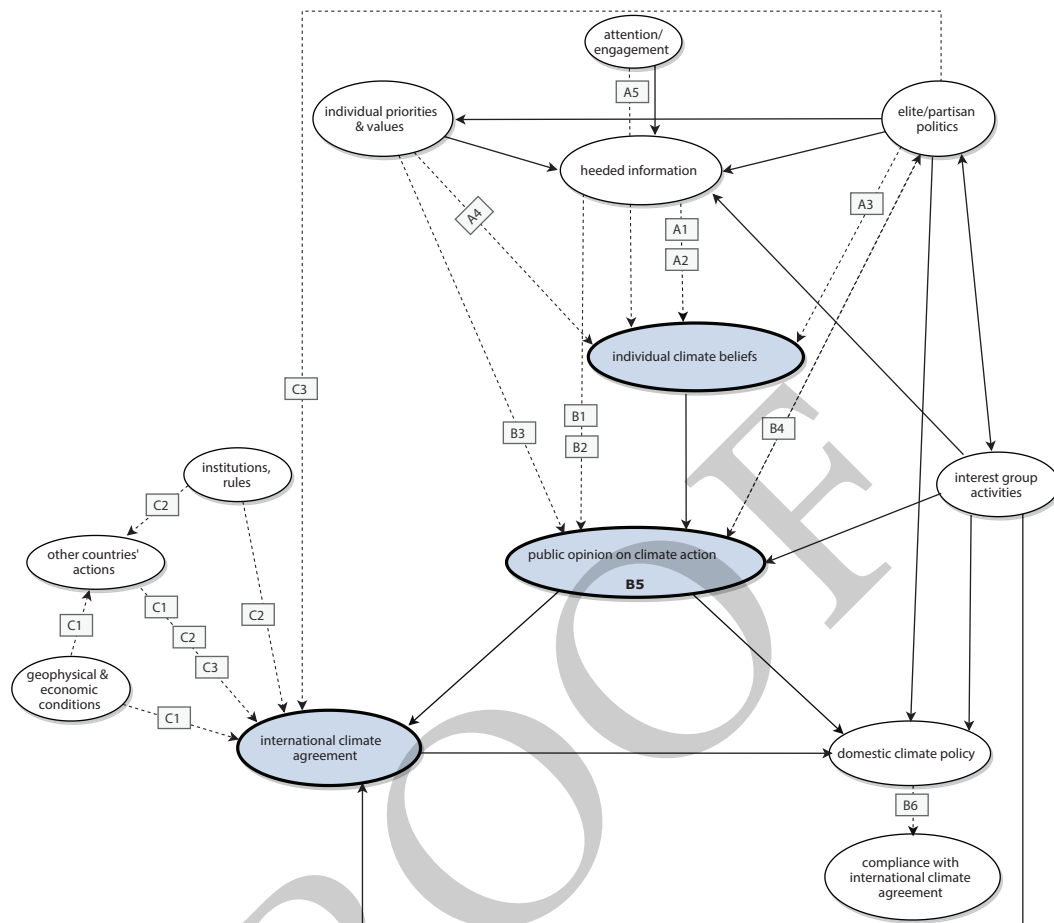
31.1 The Political Problem of Climate Change

Human activities over the past 150 years have resulted in the steadily increasing release of greenhouse gases into the atmosphere, particularly from carbon emissions. The accumulation of these gases is causing the global temperature to rise, with cascading effects on climate. Such warming will have potentially catastrophic effects, impacting human health and quality of life, economic growth, and geopolitics (USGCRP 2018).

Identifying and understanding climate change is a scientific problem, but addressing climate change is a social and deeply political problem. From a purely scientific perspective, the solution is straightforward: cut global carbon emissions. But to do so, individuals must be willing to bear costs, policymakers must identify feasible and effective actions, and nations must be able to reach and maintain agreements. Climate change presents the largest collective action problem the world has ever faced.

Figure 31.1 maps the political problem of climate change in broad terms, beginning at the level of the individual and moving to development of and compliance with an international climate agreement. Each set

Figure 31.1 Hypothesized relationships structuring the political problem of climate change.

of nodes linked by an arrow represents a general category of hypothesized influences. Figure 31.1 is intended to serve three purposes: (1) to offer a framework for thinking about how, within democracies, individual opinion funnels into coordinated climate action; (2) to map out presumed causal connections in this process, highlighting opportunities for experimentation to test these connections; and (3) to place the content and organization of this chapter in context, providing a visual reference of where the reviewed experiments fit within the larger framework and how their areas of inquiry relate.

Social science experiments on climate change tend to cluster around three outcomes: climate beliefs, attitudes toward climate actions, and climate coordination. These three nodes, highlighted in Figure 31.1, represent essential conditions for developing a solution to the collective action problem of climate change. Effective global climate action requires international coordination; compliance with an international agreement (at least in democracies) requires public support of climate policy; and public support of climate policy depends on individuals' climate beliefs. This chapter is organized around these outcomes: Section 31.2 (A1–A5) deals with experiments regarding climate beliefs; Section 31.3 (B1–B6) deals with experiments involving attitudes toward climate action; and Section 31.4 (C1–C3) deals with experiments modeling international coordination on climate change.

Each box in Figure 31.1 corresponds with a subsection in this chapter. Experiments are organized into subsections by the general causal connection they test, indicated by the placement of the box in Figure 31.1. Some of the arrows in Figure 31.1 bear more than one subsection label – this is because there are multiple ways to conceptualize and test each of these broad hypothesized connections. For example, experiments that test how information affects climate beliefs might inform respondents about the scientific consensus on climate change (A1) or test how climate *mis*information affects beliefs (A2). A related but distinct set of experiments (A5) aims to manipulate the degree of engagement respondents have with new information, rather than simply manipulating what information is on hand. Each of the arrows shown in Figure 31.1 holds the potential for numerous approaches to conceptualization and testing.[1]

A final and important point to note about Figure 31.1 is the absence of a node representing individual, voluntary emissions-reduction behaviors. Theoretically, personal behavior changes could add up to meaningful emissions reductions – indeed, a number of voluntary actions with the potential to significantly reduce emissions have been identified (Rare and California Environmental Associates 2019). However, as a discipline that studies collective action problems, political science has a responsibility to clearly convey what we know about solving such problems. Any emphasis on personal, voluntary emissions-reduction choices is almost certainly fruitless (see Olson 1965) and potentially unethical (see Hardin 1968). Our discipline can make an important contribution by insisting that we acknowledge climate change as a collective action problem that demands collective solution through policy change.

Although voluntary *emissions-reduction* behaviors have no bearing on the collective action problem of climate change, voluntary *political* behaviors have an immense contribution to make. For example, as political scientists, we also study the outsize influence of organized interests, and "interest group activities" does appear in Figure 31.1, with arrows of influence leading directly or indirectly to each of the highlighted critical junctures. While individuals choosing to adopt a more carbon-conscious lifestyle will not solve the global problem of climate change, individuals choosing to engage in organized climate activism and other individual political actions are crucial to addressing the problem. The question remains as to how to generate the necessary political will. This is an area where experimental political science can make a vital contribution.

31.2 (A) Climate Beliefs

There is overwhelming scientific consensus that anthropogenic climate change is taking place (see, e.g., Cook et al. 2016). However, the US public is divided along partisan lines in the belief that climate change is occurring, that it is caused primarily by human activity, and that it is a serious concern.

What accounts for this persistent divide? Partisans may receive or attend to different information; partisans may have different priorities that lead them to hold or report different climate beliefs; partisans' climate beliefs may be directly shaped by the positions of elites in their political party. All of these factors may play some role in shaping climate beliefs (see Figure 31.1) – and because many of the true variables of interest (e.g., a person's values) cannot be randomly assigned, even with experimentation it is difficult to untangle the discrete effects of these potential influences. But careful experimental design can help identify obstacles that stand in the way of beliefs in line with the scientific evidence, as well as treatments that help reduce the partisan divide in climate beliefs.

The first two subsections below look at experiments that provide information about climate change: A1 discusses experiments that inform respondents about the scientific consensus, while A2 focuses on the effects of

[1] The bold, solid arrows in Figure 31.1 highlight areas in which there is little or no direct experimentation relating to climate change.

misinformation on climate beliefs. The next subsection (A3) examines the role of partisanship in shaping climate beliefs, and the one that follows (A4) looks at the role of other values and priorities. Finally, A5 returns again to the role of information – but rather than altering the information that is provided, the treatments in these experiments focus on manipulating the respondent's degree of engagement with the given information.

31.2.1 (A1) Consensus

A number of experiments have tested whether simply providing people with information about the scientific consensus on climate change affects their climate beliefs.[2] A common form of the treatment message in these experiments informs participants that 97% of climate scientists agree that anthropogenic climate change is occurring. These experiments reliably find that providing this fact increases people's perception of a scientific consensus (Bolsen and Druckman 2018; Deryugina and Shurchkov 2016; Kerr and Wilson 2018; Lewandowsky et al. 2013). This is an important result, as it indicates that people generally learn from consensus information – which is not a given.

Van der Linden et al. (2018) look at how this effect varies by political ideology. The authors collect respondents' consensus estimates before and after presenting either a consensus statement (in the treatment group) or a neutral word-sorting task (in the control group). They find that the consensus statement increases percent-consensus estimates among both liberals and conservatives, with a larger effect on self-identified conservatives (van der Linden, et al. 2018, supplementary information, p. 8). This important finding provides evidence that ideology does not preclude learning from consensus information (see also Zhang et al. 2018). However, the post-treatment average estimate among conservatives (about 80% consensus) remains significantly lower than among liberals (about 90% consensus). Notably, *both* groups underestimate the

consensus despite having been given the 97% figure just minutes earlier, consistent with a finding reported by Lewandowsky et al. (2013).

While experiments have generally found that informing people about the scientific consensus increases perception of that consensus, awareness of the consensus is distinct from one's own personal beliefs about whether anthropogenic climate change is taking place. For example, you could learn and accept that the scientific consensus on climate change is larger than you previously believed, but continue to disbelieve what those scientists have to say (i.e., you accept that 97% are in agreement, but dispute their conclusions). Providing consensus information does not reliably affect other climate beliefs. Some studies have found that exposure to a consensus statement increases respondents' belief in human causation (Cook and Lewandowsky 2016; Lewandowsky et al. 2013, table 3; van der Linden et al. 2017) and concern about climate change (van der Linden et al. 2017). Other experimental work has found no effects beyond the perception of consensus (Bolsen and Druckman 2018; Bolsen et al. 2014; Dixon et al. 2017; van der Linden et al. 2015).[3]

van der Linden et al. (2015) report the mediating effect of perceived consensus on climate worry. However, although the design randomly assigns respondents to receive a consensus message, an individual's change in perceived consensus is not randomly assigned – so it is not possible to tell from this analysis whether changed perceptions of consensus caused increased concern or if instead some unobserved confounder is at work. (See Chapter 14 in this volume.)

Experimental evidence suggests that presenting people with information about the scientific consensus on climate change increases their perception of that consensus – and this appears to be true for both liberals and conservatives. One important shortcoming in this area is a lack of evidence

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2 For a more comprehensive review of consensus messaging, see Bayes et al. (2019).

3 Kobayashi (2018) finds no effect of a consensus statement on perceptions of consensus or other climate beliefs.

on whether this learning endures past the immediate experimental context.

Some evidence indicates that providing consensus information may affect climate beliefs beyond the perception of consensus – but direct effects on climate beliefs among those most likely to be skeptical have not been demonstrated. If the larger goal of consensus-message experiments is to gauge whether providing such information is a promising means of reducing the partisan gap in climate belief, then future experimentation in this category should focus on the direct effect of consensus statements on Republicans' beliefs that climate change is occurring, anthropogenic, and serious. It should carefully measure these effects both over time and in the presence of competing claims.

31.2.2 (A2) Misinformation

An important line of experimentation examines the effects of climate misinformation and ways to counter those effects. As with consensus information, giving people misinformation usually appears to affect liberals and conservatives in roughly the same way (Hardy and Jamieson 2017; van der Linden 2015). McCright et al. (2015), however, find that while a climate-denial message significantly decreases beliefs among all respondents that climate change is happening, caused by humans, and of serious concern, the depressive effect is stronger among conservatives than liberals. (The same pattern appears in terms of support for climate policy.)

Some evidence suggests that "inoculation" techniques can prevent the ill effects of misinformation. Cook et al. (2017) find that first presenting consensus information neutralizes the effect of a "false-balance" news article that gave equal weight to mainstream climate science and climate skeptics. Inoculating respondents by first explaining the misleading nature of a false-balance technique also reduced the influence of the misinformation, but not as effectively as the consensus statement. In a second study, the authors find that a "fake-expert" message – a climate-skeptical statement with

more than 31,000 signatories, over 99% of whom had no expertise in climate science – significantly reduces perceived consensus. Inoculation against this tactic somewhat reduces the effect of the misinformation (the effect was of borderline statistical significance).

van der Linden et al. (2017) find that a fake-expert message reduces consensus beliefs, consensus information increases consensus beliefs, and when presented together these two messages essentially cancel each other out, resulting in consensus beliefs that are indistinguishable from those of a control group. The effect of misinformation is reduced when the fake-expert message is preceded by consensus information, a politicization warning ("some politically motivated groups use misleading tactics to try to convince the public there is a lot of disagreement among scientists"), and then reiteration of consensus among climate experts. Additional information further undermining the fake-expert tactic (e.g., pointing out that "Charles Darwin" is one of the listed skeptics) further reduces the effect of misinformation. But even this stronger inoculation fails to completely eliminate the effect of misinformation, so that the increase in perceived consensus remains lower in the strong-inoculation group than in the group receiving only consensus information with no misinformation.

Taken together, these experiments suggest that the effects of misinformation are relatively ecumenical and very difficult to erase – though here, again, the effects of time have not been adequately explored. However, the following section on partisanship and politicization (a close cousin of misinformation when it comes to climate communication) provides evidence that leveraging source partisanship or information-engagement techniques may offer promising avenues for future experimentation on countering misinformation.

31.2.3 (A3) Partisanship and Politicization

Bolsen and coauthors find that suggesting a political motivation behind the scientific

consensus negates the effect of a consensus message (Bolsen and Druckman 2018) and decreases perception that climate change is happening (Bolsen et al. 2019). Bolsen and Druckman (2018) are unable to undo these deleterious effects of politicization with either inoculation or an after-the-fact correction. However, Bolsen et al. (2019) find evidence that engaging visuals (animated maps illustrating climate impacts) *can* neutralize the effect of politicization on belief that climate change is happening.

Benegal and Scruggs (2018) look at how partisanship affects the impact of a corrective statement from a source. The authors expose all participants to an article containing misinformation about climate change and quotations from a Republican senator proclaiming anthropogenic climate change a hoax. Treatment conditions received corrections to this misinformation coming from either Republican senators, Democratic senators, or NASA scientists. Correction from the Republican senators significantly increases Republican and Independent respondents' perceptions of consensus, belief that climate change is anthropogenic, and belief that climate change is an important problem (relative to no correction). Corrections from Democratic senators, on the other hand, showed no effect on any beliefs for any respondents.

Partisanship, like values or beliefs, cannot be randomly assigned, making it difficult to precisely discern its causal role in shaping climate beliefs. However, simply highlighting one's partisan identity, with no reference to any particular stance or attitude toward climate change, can affect climate beliefs. Unsworth and Fielding (2014) demonstrate that a treatment priming political identity significantly decreases perceived human contribution to climate change among participants who identified with a right-wing party, but not among those who identified with a left-wing party.

The effectiveness of this simple treatment in shifting stated belief raises a question about the extent to which reported climate beliefs reflect truly held beliefs. Rather than indicating that merely thinking about party identification changes one's beliefs about the world, this finding could result from people using reported beliefs about the nature of climate change as a means of communicating more complicated messages about party support or policy preferences (e.g., "It may be that human activity is causing climate change, but I do not think climate change will negatively affect my own life enough to merit taking on whatever personal costs would be associated with government action to address it"). We might gain additional insight into nuances of this sort from probing, open-ended questions, collected after the primary outcome variable, asking respondents to tell us more about their selected response.

31.2.4 (A4) Values and Priorities

As with partisanship, strictly speaking, values and priorities cannot be randomly assigned – and so investigating their influence on climate beliefs presents similar experimental challenges. Treatments that are able to shift values and priorities could be used to test for downstream effects on belief. Alternatively, researchers can examine how treatments that satisfy presumed concerns associated with certain values or priorities affect people's reported climate beliefs.

For example, to the extent that expressions of climate skepticism are rooted in concern about excessive government regulation in response to climate change, treatments that assuage those concerns should also decrease reports of climate skepticism. Campbell and Kay (2014) find that Republican (but not Democratic) respondents are significantly more likely to report beliefs that climate change is real and anthropogenic when assigned to read about a free-market-based climate solution than when assigned to read about a government regulation solution. Dixon et al. (2017) find that a testimonial endorsing a free-market-based climate solution increases belief in anthropogenic climate change among self-reported "conservative" and "very conservative" respondents (compared with no testimonial), but not among less conservative respondents.

Van Prooijen and Sparks (2014) test the effect of value affirmation more generally. Among participants who showed indications of a climate-skeptical disposition,[4] those assigned to write about a value important to them and how they had applied it in everyday life show greater acceptance of climate information. And Jang (2013) cleverly uses a value-threat approach to demonstrate that a combination of in-group preference and considerations of blame and responsibility influence reported climate belief. American respondents presented with information about Americans' excessive energy use are more likely to report that climate change is due to uncontrollable (natural) causes rather than human causes compared with Americans exposed to information about excessive energy use in China or a control group.

Another approach is to test whether evoking (rather than satisfying or threatening) certain values moves climate beliefs. Feinberg and Willer (2013) examine whether a pro-environmental message appealing to purity, a moral value that resonates with conservatives, affects conservative beliefs. The authors find that conservative respondents report greater belief in global warming when exposed to the purity/sanctity message compared with both a harm/care pro-environmental message and a control message. Wolsko et al. (2016) find that conservative (but not liberal) respondents presented with a "binding morality" climate message (emphasizing loyalty, authority, purity, and patriotism) show higher scores on a climate-belief composite scale (rating concern and human causation) than when presented with an "individualizing" morality frame or a control message. Such appeals, though, are designed more to estimate the effectiveness of different treatments, rather than to uncover the influences shaping belief.

31.2.5 (A5) Reflection and Engagement

A number of experiments have examined how techniques designed to increase engagement

with or reflection upon climate information affect climate beliefs. Although information-engagement treatments presumably operate by changing what information is heeded, testing for such mediation effects is exceedingly difficult (see Chapter 14 in this volume). Because the experiments here primarily test the effect of treatment on climate beliefs (as opposed to the effect on heeded information – though see Chapter 12 in this volume regarding the importance of manipulation checks), this subsection is shown in Figure 31.1 labeling the arrow between engagement and climate beliefs.

Guilbeault et al. (2018) present an innovative design demonstrating that the opportunity to revise one's position after exposure to others' climate beliefs in bipartisan networks (structured to represent social media networks) can counteract partisan bias in the interpretation of climate data. Jamieson and Hardy (2014; see also Hardy and Jamieson 2017) employ an engagement technique that leverages scientific authority, involves the audience, visualizes the data, and contextualizes the data with an analogy. The authors demonstrate that a misleading news article makes all respondents (regardless of political ideology) less accurate in their interpretation of climate data than a control group – but that combining the misleading article with the engagement treatment erases the effect of the misinformation. Among conservatives, the misinformation plus information-engagement treatment produces even greater accuracy than is exhibited in their control group (i.e., conservatives who receive no misinformation). (See also Bolsen et al. 2019, described in A3.)

Baumer et al. (2015) show that encouraging scrutiny of the framing of a message (called "frame reflection") interacts with the effect of presenting a climate message in terms of global warming or climate change. Among conservatives, questions using the term "global warming" have been found to elicit more climate-skeptical responses than questions using the synonym "climate change" (Saunders 2017; Schuldt et al. 2011, 2015, 2017; see also Jaskulsky and Besel

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4 In other words, respondents who, in a pre-survey, showed greater-than-average skepticism on a subscale of the New Ecological Paradigm measuring the "fragility of nature's balance."

2013), and Baumer et al. (2015) replicate this finding. But a treatment that briefly explains the concept of framing (using certain words/phrases to induce a certain perspective) before presenting the global warming/climate change message reverses this framing effect: the frame-reflection treatment causes conservatives to express significantly more belief in "global warming" than they do in the absence of a prompt to reflect on the question frame. Moreover, within the frame-reflection treatment group, conservatives express slightly more belief when asked about "global warming" than when asked about "climate change" – perhaps as an effect of recognizing one's own suscep- tibility to framing, which would be more salient in the "global warming" condition than in the "climate change" condition.

Druckman and Shafranek (2017) prompt reflection and reassessment even more directly. When reporting their beliefs about climate change, people are influenced by their own perceptions of the day's local temperature (Druckman 2015; Egan and Mullin 2012; Joireman et al. 2010; Lewandowski et al. 2012; Li et al. 2011; Risen and Critcher 2011; Zaval et al. 2014). This is known as the local warming effect. Druckman and Shafranek (2017) show that a simple reminder – "When thinking about temperatures over the last year, remember not only the feeling of today but also how you felt throughout last winter, spring, and summer, when temperatures were different" – severs the relationship between current tem- perature and global warming beliefs within the treatment group. The authors recontact all respondents after seven days and find that the initial prompt (not readministered) still exhibits its corrective effect.

31.2.6 Next Steps

Investigators looking to study climate beliefs should first consider the ultimate goal of their research. If the end purpose is to help solve the global collective action problem presented by climate change, then climate beliefs may not be the most effective area for intervention. First, some evidence

suggests that the partisan divide in reported belief may be more a reflection of policy preferences (see Campbell and Kay 2014; Dixon et al. 2017) and partisan allegiance (see Unsworth and Fielding 2014) than of truly held belief. To the extent that this is the case, then taking great pains getting people to say that climate change is anthropogenic may be effort misspent. Of course, deeply committed climate skeptics certainly exist. But if the fairly pervasive conservative skepticism reflects something other than considered belief, then closing the partisan gap in reported climate belief may leave us unmoved toward a climate solution. Moreover, as indicated by the solid, unlabeled arrow between climate beliefs and climate policy attitudes in Figure 31.1, we have no experimental evidence about the effect of climate beliefs on attitudes toward climate action.

In short, some evidence hints that the partisan divide on climate change is a policy issue, not a belief issue. But even if we assume that all climate beliefs are truly reported, we have no evidence that successfully moving people's beliefs into alignment with the scientific consensus is an effective means of increasing support for climate action.

31.3 (B) Climate Action

Attitudes toward climate action are distinct from – though presumably related to – beliefs about whether climate change is occurring, anthropogenic, and serious. As Figure 31.1 suggests, an individual's attitudes toward climate action are likely related to their climate beliefs, but are also likely to be shaped by that person's values and priorities, their information at hand, and by partisan politics. A person may hold beliefs entirely in line with the scientific consensus on climate change but be unwilling to bear the costs associated with a particular climate action because of their prioritization of current versus future well-being. And as discussed above, people who report climate-skeptical beliefs may nevertheless be supportive of certain climate actions.

Just as it is worth clarifying the distinction between climate action and climate belief, it is also important to distinguish between different forms of climate action. The term "climate action" could refer to:

- Personal, voluntary emissions-reduction behavior – an individual action.
- Climate activism – i.e., political expression of climate attitudes. This is also an individual action, but one directed toward collective action.
- Climate policy – i.e., governmental action. The governmental action of policy creation sets the guidelines that structure collective action.

This section deals primarily with attitudes toward governmental action/climate policy. It deals only briefly with climate activism. This brevity is not due to a lack of importance (as noted in Section 31.1, political action is crucial), but to the relative dearth of experiments with climate activism or political expression as an outcome (see Buntaine and Prather 2018; Levine and Kline 2017, 2019). With two exceptions (B5 and B6), this section sets aside experiments that look at personal intentions or behaviors as an outcome. As discussed above, individual voluntary behaviors in and of themselves have no bearing on the macro political problem of climate change, which requires global coordination, not personal commitments.[5]

This section first looks at experiments that test how different attributes of a policy affect people's attitude toward that policy (B1), then turns to how different economic or geopolitical contexts affect people's policy preferences (B2). The next two subsections examine how emphasizing different values or priorities (B3) or providing party cues (B4) affect attitudes toward climate actions. Experiments in the last two subsections use behavioral outcomes as measures of a broader concept – in B5, as a measure of willingness to bear costs; and in B6, as a measure of policy effectiveness.

31.3.1 (B1) Policy Attributes

Conjoint experiments (see Chapter 2 in this volume) provide a useful means of isolating the effects of specific policy attributes on support for a policy. Bechtel and Scheve (2013) field a conjoint design in four countries (France, Germany, the UK, and the USA) to examine how attributes like cost, burden sharing (cost distribution and participation levels), and enforcement mechanisms affect attitudes toward hypothetical cross-national climate agreements. Despite large differences between the four countries in general support for international climate efforts (e.g., Engels et al. 2013, replicated by Bechtel and Scheve 2013), the authors find broad agreement across all four countries on which policy attributes matter. Notably, the main determinant of policy support is the monthly cost to an average household. Moving from expected household costs of 0.5% of gross domestic product (GDP) to 2% of GDP decreases support by 25 percentage points on average.[6]

Gampfer et al. (2014) field a conjoint experiment in the USA and Germany focusing on emissions-reduction aid to poor countries and also find that the cost borne by the donor country (i.e., either the USA or Germany) is the primary factor driving support for the policy.[7] As Bechtel and Scheve note, "The high degree of sensitivity to price sets a noteworthy qualification to the common characterization in the public opinion literature that there is strong public support for addressing climate change." (2013, p. 13764).

Bechtel and Scheve (2013) report an extremely important implication of their findings: their results suggest that institutional design choices can move popular support in a decisive fashion. For each country, the authors compare a scenario featuring attributes roughly reflective of the

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5 Though see Johnson (2003, 2011) and Hourdequin (2010, 2011) for an interesting exchange on the ethics of individual actions in response to climate change.

6 In the USA, 2% of GDP corresponds to roughly $213 per household per month.

7 In Sweden, however, Brannlund and Persson (2012) conduct a conjoint climate policy experiment and find that how costs are *distributed* plays a major role – as does whether or not the policy in question is referred to as a "tax."

real-world proposals under consideration at the time with the support-maximizing scenario in that country (i.e., featuring the attributes that, within the given country, garnered the most support). In three of the four countries studied, moving from the "real-world" proposal to the support-maximizing proposal shifts a majority of respondents from rejecting the agreement to a majority indicating support. The USA is the lone holdout among the four countries: even the most popular proposal in the USA fails to win over a majority of respondents – but it comes close.

31.3.2 (B2) Contextual Considerations

How does information about relevant external circumstances affect support for climate policy? A number of survey experiments have examined how information about other countries' actions affect attitudes toward climate policy, with mixed results. Surveying respondents in China and the USA, Beiser-McGrath and Bernauer (2019) find that treatments informing respondents about other countries failing to reduce their own emissions did not affect climate policy design preferences (see also Bernauer and McGrath 2016). Tvinnereim et al. (2016) find that China's participation has no effect on support for an international commitment in the USA and Canada (though it does matter in Norway and Sweden). And Stroik (2019), fielding a survey experiment in China and the USA, find that being informed of the other country's nonsupport does decrease respondents' support for signing an international emissions reduction treaty. Looking instead at the effect of economic conditions, Kachi et al. (2015) field a survey experiment in the USA and Germany and find that neither positive nor negative news about the domestic economy affects public support for climate policy.

Although on the whole these findings lean towards a picture of domestic opinion on climate policy as not particularly sensitive to the broader circumstances, drawing conclusions from null findings is tricky. The mix of findings and the paucity of experiments

in this area suggest room for further experimental development. However, the independent variables in this category are outside of anyone's control. This means that, while such experimentation may be informative, if the goal is to contribute useful information toward designing or achieving climate action, the findings may not be particularly germane.

31.3.3 (B3) Values and Priorities

Among social science experiments on climate change, those testing for framing effects on support for climate action constitute the largest single category. Framing experiments often aim to investigate how bringing to mind various priorities – for example, economic equity, efficiency, or costs (Anderson and Bernauer 2016; Bernauer and McGrath 2016; Nolan and Tobia 2019; Severson and Coleman 2015; Zhou 2016), national security (Singh and Swanson 2017; Zhou 2016), health impacts (Bernauer and McGrath 2016; Hart and Nisbet 2012; Levine and Kline 2017) – or values (e.g., Anderson and Bernauer 2016; Clayton 2018; Hart and Nisbet 2012; Severson and Coleman 2015; Singh and Swanson 2017; Zhou 2016) affect reports of support for various climate actions. In addition, there is a wealth of other experimental work that tests for framing effects on attitudes toward climate action, including work on gain versus loss perspectives (Bertolotti and Catellani 2014; Bilandzic et al. 2017; Hurlstone et al. 2014; Levine and Kline 2019; Nabi et al. 2018), emotion (Lu and Schuldt 2015, 2016), and message congruence or specificity (Bertolotti and Catellani 2015; Dickinson et al. 2013).

Note that Figure 31.1 shows these experiments testing the causal effect of priorities and values on attitudes toward climate action – not the effect of *information* on attitudes toward action. Framing is a method intended to rely not on learning new information, but on prompting people to weigh or consider an issue differently, without necessarily having learned anything new.

It is difficult to discern a general lesson to be learned from the results of these studies – indeed, many report little or no effect of

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the different treatment frames (Bernauer and McGrath 2016; Singh and Swanson 2017) or mixed results that are difficult to interpret as a whole (e.g., Severson and Coleman 2015). Certainly no studies have yet identified a frame that reliably produces large effects.

Because combinations of frames and particular climate actions are potentially infinite, framing experiments conducted outside of an overarching agenda run the risk of triviality, cycling through possibilities without leading toward applicable understanding. Testing for framing effects on climate actions may be premature without greater clarity on which actions are relevant. Once specific climate policies have been identified as likely to come before the public eye, knowing how best to frame those policies for various audiences is extremely useful. Another productive use of framing experiments is in combination with behavioral measures that gauge relative willingness to bear costs, discussed in B5.

31.3.4 (B4) Party Cues

Experiments that manipulate which political party is associated with a particular climate policy or proposal show that party cues clearly affect attitudes toward climate actions. For example, Van Boven et al. (2018) show that, among both Democrats and Republicans, support for a climate policy drops significantly when the policy is described as proposed by an out-party politician compared with the identical proposal from within one's own party. However, despite the depressive effect of out-party cues for both parties, Republican proposal of the climate policy produces an important set of results. Republican sponsorship moves Republican respondents over the threshold from a lack of support ("neither agree nor disagree" with the policy) to support for both a cap-and-trade policy and a revenue-neutral carbon tax policy. And although Republican sponsorship reduces Democratic support relative to the same policies as proposed by a Democrat, the Democratic average remains significantly above the threshold of support for both policies. In other words, when proposed by a Republican politician, the policies

retain support from both Democratic and Republican respondents, on average.

Ehret et al. (2018) conduct a similar experiment but add ecological validity by setting their experiment in the context of a Washington State climate initiative that garnered support and opposition from both parties. Surveying registered voters in Washington State and using a subtle and veridical treatment (two lists showing the partisanship of supporters and opponents were featured alongside an explanation of the policy proposal), the authors find effects of partisanship among Democratic voters, but not Republicans, who indicated uniformly low support for the initiative.

Kousser and Tranter (2018) make use of the Australian context for ecological validity. Although Australian political parties (and the public) are generally polarized over climate change, the recent leadership of an atypically pro-climate conservative provided an opportunity to estimate the effect of elite support for climate policy using real-world variation. The authors find that informing people that the leaders of both parties agree on an emissions trading scheme causes conservative-identifying respondents to become more supportive of the policy and respondents identifying with the left-leaning parties to become less supportive (compared with partisan respondents receiving no elite-position information). This suggests that partisans on both sides are gleaning information from the conservative leader's policy support: "[L]earning that the scheme was supported by Malcolm Turnbull led left-wing respondents to conclude that it was not as environmentally progressive as they might have thought" (Kousser and Tranter 2018, p. 105). Encouragingly, as in Van Boven et al. (2018), conservative endorsement is enough to move conservatives from opposition to support, while liberals remain supportive despite the dip caused by the conservative endorsement.

31.3.5 (B5) Behavioral Measures

The studies described in the preceding sections mostly rely on survey reports about

policy support. Few raise the question of trade-offs or costs associated with climate action (see Anderson and Bernauer 2016; Bechtel and Scheve 2013; Gampfer et al. 2014; Nolan and Tobia 2019). Behavioral outcomes can provide a measure of how people's willingness to bear the costs of action changes under different experimental conditions. Rather than testing any single causal connection, the experiments in this section share in common the use of behavioral outcomes as a measure of climate attitudes. As such, rather than labeling an arrow, Figure 31.1 shows this subsection labeling the node "public opinion on climate action." This placement reflects that these experiments measure an expression of attitudes toward climate action – in particular, people's relative willingness to bear the costs of action.

For example, Löschel et al. (2017) use willingness to purchase emissions allowances through the European Emissions Trading Scheme as an outcome variable. All participants receive €40 in cash for taking part in the study, then receive information about climate change and about how purchasing allowances from the European Union emissions trading scheme reduces emissions. The authors find that, relative to emissions purchases in a control group, an enforced collective action mechanism (each group member indicates their preferred purchase amount and all group members are then obliged to purchase the median amount) dramatically increases contributions, moving median willingness to pay from €5 per ton of CO_2 reduction to €25 per ton of CO_2 reduction. There is no effect of a social influence condition, in which group members are informed of the emissions reduction achieved by a previous test group.[8]

As another measure of willingness to bear personal cost, Buntaine and Prather (2018) give respondents an opportunity to divide a potential $20 lottery award between a donation to a World Resources Institute (WRI) mitigation program in the USA, a donation to a WRI program in rapidly

developing countries, and an amount to be kept by the respondent. The authors find that, in a control group, respondents donate more to the US program than to the developing country program – but a message about the greater cost-effectiveness of mitigation in developing countries reverses this ordering (without affecting the amount that respondents keep for themselves).

In the same study, Buntaine and Prather (2018) employ another type of behavioral outcome, this time measuring willingness to take political action. Respondents are given an opportunity to write and submit a note through the websites of the US President and the respondent's Congressional representatives, conveying their views about US government spending on climate mitigation. The effects on this outcome move in the opposite direction of the authors' donation finding. Learning about the greater cost-effectiveness of mitigation abroad appears to exacerbate respondents' "home preference," with significantly greater letter-writing on behalf of the US than on behalf of the developing countries.

Levine and Kline (2019) partnered with an environmental organization to conduct a field experiment for which the outcome was signing a petition to state officials advocating climate action. The authors find that a loss frame decreases willingness to take climate action. (See also Levine and Kline 2017, which includes signing a petition addressed to global leaders as a field-experimental outcome.) van der Linden (2015) finds that a climate conspiracy video decreases the likelihood of signing a "stop global warming" petition among both liberals and conservatives.

Gampfer (2014) and Anderson et al. (2017) use ultimatum games to investigate how considerations of fairness influence individuals' climate mitigation preferences. Both studies report that ability to pay and historical responsibility affect people's determinations of what is fair in terms of climate policy.

Though the costs involved in these behavioral measures are necessarily small relative to the actual costs required by any effectual climate policy, such measures nevertheless provide a useful relative gauge

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8 Note that this runs counter to the finding on conservation behavior in Goldstein et al. (2008).

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of how different treatments affect willingness to bear costs. As noted above, such behavioral measures can be productively used as outcomes in framing experiments, testing what motivations (e.g., moral imperative) or objectives (e.g., avoiding natural disaster) prove more and less compelling to different groups in terms of willingness to bear costs. Of course, a frame that makes people *more* willing to accept a modest cost will not necessarily move people over the threshold from opposition to support of climate policy – the track record of framing experiments on climate action does not give great optimism that frames can move people from opposition to support. But at the very least, these outcome measures can illustrate the extent to which different considerations resonate for different groups of people.

31.3.6 (B6) Field Experiments

Levine and Kline (2017; 2019), described in B5, present a rare model of a field experiment with climate activism as an outcome.[9] More often, field experiments pertaining to climate look at how a potential policy change would affect individuals' personal behaviors. In other words, climate-related field experiments often aim to gauge policy effectiveness. Figure 31.1 shows this subsection labeling the arrow connecting domestic policy to compliance, as the experiments test the extent to which particular policies may lead to actual emissions reductions.

Jayachandran et al. (2017) test the efficacy of a payment for ecosystem services (PES) program in Uganda and find that the program reduces tree-cover decline, with no evidence of deforestation shifting to nearby land. Jayachandran et al. find the program to be cost-effective, calculating the value of delayed carbon emissions due to the program as 2.4 times the cost of implementing the PES program.

9 Stokes (2016) presents another example of a field study that uses support for climate action as an outcome. However, because the independent variable is not randomly assigned, the design does not constitute a strict field experiment. See Chapter 6 in this volume.

Gillingham et al. (2017) describe the results from a campus carbon-pricing experiment. In the lead-up to campus-wide implementation of a carbon price, 20 buildings were selected for a pilot study and randomly assigned to one of four approaches: (1) no carbon pricing, but receipt of a monthly energy report; (2) carbon-pricing revenue earmarked for energy-efficiency actions; (3) carbon-pricing revenue redistributed to buildings that reduced their emissions by at least 1% relative to their emissions history; or (4) revenue-neutral pricing, with a net charge applied to buildings where emissions reductions were below average and a net rebate where reductions were above average. The remaining campus buildings constituted the control group. The study finds that a carbon charge decreases carbon emissions by around 5 percentage points relative to the control, whereas the monthly report with no pricing has no effect on emissions relative to the control (Gillingham et al. 2017, supplementary information).

31.3.7 Next Steps

Researchers studying climate action should bear in mind that, because climate change is by nature a global collective action problem, individuals' voluntary emissions-reduction behaviors are not directly relevant to solving the political problem. Equally important is recognizing that domestic public opinion on climate policy is integral to arriving at and adhering to an international climate agreement.

Experiments on attitudes toward climate action can make a number of important contributions. Conjoint experiments provide an excellent tool for assessing which aspects of climate policy matter to the public. Given the findings in Section 31.2 (A1–A5) suggesting that the partisan divide in climate belief may be in some respects a policy dispute, identifying effective policies that appeal to different segments of the population may be a higher-priority task than we currently acknowledge. Already, conjoint experiments have made fairly clear that what matters most

(to most publics) is a policy's cost. Future conjoint experimentation should make realistically high costs fixed and explicit and focus on identifying what policy characteristics draw the greatest willingness to bear those costs.

As noted above, framing experiments on specific climate actions in the absence of realistic policy prospects may be premature. Until the most promising policies are identified, framing experiments may best be deployed in combination with behavioral outcomes measuring willingness to bear costs. This could shed light on what considerations make people willing to bear the high costs of effectual climate action.

An especially important contribution of both framing experiments and conjoint experiments would be to identify which policy attributes and what motivations or objectives are most appealing to those *least* likely to be supportive of climate action. The findings regarding the influence of party cues on policy support give reason for optimism, suggesting that endorsement by conservative elites may, in some cases, be sufficient to flip conservative voters from opposition to support, without driving liberals to opposition. The evidence from Ehret et al. (2018), who test the effects of party cues in a real electoral setting, should not quell that optimism, but instead be taken as a signpost indicating an important area for further experimentation: Under what conditions is conservative endorsement sufficient to move voters from opposition to support?

31.4 (C) Climate Coordination

Addressing climate change requires global action. The USA and China are by far the highest emitters of greenhouse gases, but together the two countries produce less than half the global total. What considerations should be taken into account when trying to craft international agreements on climate change? Fundamental problems of coordination and collective action (e.g., free-riding, assurance) are accompanied by a number of complicating factors: the

equitable distribution of costs (how to factor in historical responsibility, capacity, climate vulnerability), the crucial role of domestic public opinion, and a moving target, as the problem becomes more difficult to solve the longer it goes unaddressed. This section focuses on experiments that aim to help us understand how best to facilitate international coordination on climate change, considering the factors over which we do have control (e.g., rules governing the negotiating process), those over which we do not have control (e.g., the inherent uncertainty of geophysical systems), and the interdependence of multiple autonomous decision-makers.

The experiments discussed in this section use economic games to study the outcomes that emerge with multiple, interacting decision-makers. The assumption behind the use of such games is that behavior in settings with real (though minimal) costs and representative (though abstract) conditions may shed light on behavioral tendencies in the real world. All of the games discussed here make some effort to represent economic and climatic conditions, all incorporate the effects of other actors' decisions, and all involve some rules governing the interactions of the players. Few of them explicitly consider domestic public opinion or other political influences.

The first subsection (C1) focuses on the characteristics required for a behavioral game to adequately model the climate coordination *setting*. Although the studies in this subsection include experimental tests, here these studies serve primarily as a guide to the constraints that create a suitable foundation for a climate coordination game. The next subsection (C2) describes experiments testing the effects of various rules or institutions – conditions over which we have real-world control – on players' ability to arrive at agreements that stave off climate catastrophe. In short, C1 describes the necessary characteristics for an informative climate coordination game and C2 illustrates useful application of experimental treatments within such a game setting. C3 reviews a different approach to learning about climate

coordination, discussing studies that recruit climate elites to participate in experiments.

Figure 31.1 illustrates one of the ways in which the economic games in this section differ from the experiments discussed above. These games allow for the interaction of multiple decision-makers and draw multiple causal pathways into consideration. Reflecting this, each subsection is shown in Figure 31.1 labeling multiple arrows. The experiments in C1 consider the effect of geophysical and economic conditions on achieving international coordination, those effects on other countries' (i.e., players') actions, and the effects of other countries' actions on international coordination. The experiments in C2 consider the effects of rules and institutions on international coordination and on other countries and the effects of other countries' actions on international coordination. C3 draws in the role of partisan politics by recruiting elite players.

31.4.1 (C1) External Circumstances: Game Setting

One of the most important tasks in the design of a climate coordination game is appropriately modeling all of the crucial constraints imposed by climate change. Economic games are necessarily abstract, but they need not be simple. Such games provide an opportunity to gain insight into patterns of human behavior that emerge in complex situations featuring multiple actors, each weighing multiple considerations. Leaving out any one of the key constraints may dramatically change behavior, rendering the game behavior uninformative. Theory can guide us to the considerations that are likely important, and testing can indicate which of those considerations influence behavior, at least in a laboratory or game setting.

What are the key characteristics for an informative climate coordination game? Fennewald and Kievit-Kylar (2013) write that a climate change game should at minimum consist of a common-pool resource dilemma with multiple actors who have both diverse capacities and diverse interests.

It should also incorporate second-order delayed effects, representing temperature increases that are not an instant effect of greenhouse gas emissions, but a delayed effect of the persistent presence of accumulated greenhouse gases.

Kline et al. (2018) provide a model of a climate coordination game that includes the first set of features, but not the delay in effects. In this game, a threshold is set representing the cost of successful climate change mitigation efforts. Players representing climate actors/countries each have an endowment, and over several rounds, each player chooses a contribution to make toward the mitigation cost threshold. If, after the final round, the total contributions of the group have not reached the threshold for successful mitigation, then catastrophic economic loss occurs with some probability (P) known to the players. Here, catastrophic economic loss is represented by the loss of all remaining endowments of all players.

The authors add a further aspect of climate change by endogeneously determining three key parameters: initial wealth (endowment), level of collective risk (P), and the threshold for averting climate catastrophe. These endogenous characteristics are determined in a first-stage round by the extent to which players choose to extract from the common pool. This extraction builds a player's own wealth while also increasing the probability of catastrophic loss in the next round and increasing the costs of averting such loss. While endogenizing these parameters provides a more faithful representation of historical responsibility, a drawback is that it can produce scenarios unrepresentative of the real-world problem. The question is whether behavior in the second-round mitigation differs when players are *actually* responsible for wealth and risk compared with a mitigation round in which roles are assigned and responsibility is ascribed through a descriptive scenario. If behavior does differ between two such designs, the question becomes which version more accurately reflects how climate actors would behave in the real world – a much more difficult question to answer.

In general, designs should hold fixed those features of the climate problem over which we have no control. These characteristics – such as inequality among actors, both with respect to wealth (see, e.g., Brown and Kroll 2017; Tavoni et al. 2011; Vicens et al. 2018) and risk (Burton-Chellew et al. 2013), the magnitude and probability of climate impacts (Barrett and Dannenberg 2012; Hasson et al. 2010, 2012; Milinski et al. 2008), the degree of persistence of greenhouse gases (Calzolari et al. 2018), or the degree of scientific uncertainty (e.g., Barrett and Dannenberg 2014; Brown and Kroll 2017) – should be set so as to reflect the current state of the world, to the best of our ability and knowledge. This is true even with characteristics over which there is considerable and inherent uncertainty. If the goal is to identify controllable factors that promote climate coordination, it is more informative to test the effects of different rules or institutions within a context that best represents the real social, political, and geophysical background than it is to test how, for instance, varying the magnitude of impacts affects coordination. In the real world, manipulating the magnitude of climate impacts is out of the question.

One of the most bedeviling obstacles to addressing climate change is the remove between cause and effect, which Fennewald and Kievit-Kylar (2013) characterize as the problem of second-order delayed effects. Sherstyuk et al. (2016) provide one of the few studies that attempt to model this crucial characteristic. In each round of this game, players choose some level of extraction, which affects their own current payoff, as well as some level of mitigation investment, which affects the payoff level among *different* players in a subsequent round. Although there is no monetary incentive to care about the future, Sherstyuk and coauthors report that the players in this condition tend to restrain their extraction below what would be predicted for purely selfish choices.

Jacquet et al. (2013) use a clever technique to model the intergenerational aspect of climate outcomes. In one condition of this game, any monetary endowment that is protected from loss through successful mitigation efforts is spent on planting oak trees (instead of being retained by the players). While this nicely draws real-world intergenerational benefits into the game, one notable difference from the climate problem is that, in this model, next-generation effects constitute *benefits* received or forgone (the presence or absence of oak trees) as opposed to *loss avoidance*, which more closely reflects the scenario of climate change (the presence or absence of climate catastrophe).

Del Ponte et al. (2017) provide perhaps the closest representation of second-order delayed effects. The authors include a condition in which an endogenously created threshold (based on players' extraction in a first round) is applied to a different set of players in a second round who must make mitigation contributions in order to avoid catastrophe. While Del Ponte and coauthors model this crucial condition quite well, to even more closely represent the climate dilemma, the mitigation decisions (representing choices made in the present) could lead to an outcome that will fall upon yet a third group, representing our future selves and others (see, e.g., Pronin et al. 2008).

Other crucial external circumstances to incorporate into a climate coordination game include a target that becomes harder to reach as time passes (see Gosnell and Tavoni 2017) and considerations of domestic public opinion.

31.4.2 (C2) Effects of Rules/Institutions

An economic game that incorporates crucial characteristics of climate change – that is, a collective-risk social dilemma (Milinski et al. 2008) involving players with diverse resources and vulnerabilities, second-order delayed effects, and a moving target – provides an excellent setting for experiments testing how various rules may affect players' behavior. As noted above, the assumption is that behavior in these games may indicate how elite actors would respond under analogous circumstances and illuminate how best to promote global climate coordination. The experiments detailed here explore how

different rules and institutions affect the chances of achieving a successful outcome.

Gsottbauer et al. (2018) test the effects of a liability mechanism – proposed but not adopted in the Paris Agreement – on climate mitigation investments by countries that differ in wealth and in climate vulnerability. The authors compare a negligence rule and a contributory negligence rule against a control condition with no liability rules. The negligence rule holds the rich country liable for the poor country's climate losses only if the rich country did *not* invest in mitigation; the contributory negligence rule holds the rich country liable only if the poor country *did* invest in mitigation. Both liability rules, which align individual and group incentives, increase cooperation and willingness to invest.

Feige et al. (2018) use an experiment to investigate the effects of the consensus decision-making procedure that the United Nations Framework Convention on Climate Change (UNFCCC) uses to determine national abatement efforts. The authors test the effect of a nonbinding unanimous voting procedure on voluntary contributions in a threshold public goods game. They find that even though the procedure has no enforcement mechanism, it produces high rates of compliance with the contribution proposals that are adopted by vote. However, the voting treatment does not increase average contributions or rates of success at reaching the threshold.

Barrett and Dannenberg (2016) test a "pledge and review" process like that in the Paris Agreement. In this process, each country commits to an emissions-reduction level, and its progress toward fulfilling its commitment is made public and evaluated. The authors find that although announcement of a review process appears to increase targets and pledges, there is little evidence of an effect on actual monetary contributions (representing emissions reductions).

Bosetti et al. (2017) use a threshold public goods game to study the effects of two abatement-encouragement mechanisms on mitigation among players who choose *not* to sign a climate agreement. The authors

test the effect of signatories signaling their commitment and the effect of allowing the benefits of a "clean technology" to spill over to non-signatories versus accruing only to signatories. Bosetti et al. report that the introduction of a signaling stage, in which players can indicate their commitment to signing a climate agreement that restricts their use of a "polluting" technology, does decrease investment in the polluting technology, but not enough to affect the probability of crossing a catastrophic threshold. Introducing benefits of "clean technology" investments that spill over to non-signatories significantly improves the chances of avoiding disaster.

Gosnell and Tavoni (2017) test how the opportunity for side deals affects simulated climate negotiations in a bargaining game. Unlike the previous studies, this game is presented with an explicit climate change frame, including a brief explanation of climate change and of international negotiations on emissions reductions. The authors find that introducing side deals does not improve the ability to reach agreements. Brick and Visser (2015) use a public goods game with an explicit climate change framing to test the effects of communication and of voluntary contribution versus a carbon tax. The authors find that communication between parties does increase contributions, but not enough to meet the mitigation threshold. In contrast, a carbon-tax condition – in which a minimum contribution to the public good is specified and free-riding is fined – draws very high compliance. The tax crowds out contributions in excess of the minimum contribution requirement, but because of high compliance, the mitigation threshold is met as long as the tax level is set appropriately.

31.4.3 (C3) Climate-Elite Participants

Dannenberg et al. (2010) and Akpalu et al. (2017) take a different approach to climate coordination games by recruiting climate decision-makers as participants (see Chapter 8 in this volume). Dannenberg and coauthors (2010) measure preferences about fairness and equity among individuals involved in

international climate-policy negotiations. The authors collected names and contact information from official Intergovernmental Panel on Climate Change (IPCC) documents and websites and successfully recruited 155 participants (around 8% of invitees). The climate negotiators played two games: Game A measured their aversion to receiving less than another player (disadvantageous inequality aversion) and Game B measured their aversion to receiving more than another player (advantageous inequality aversion). Though the study presents an interesting use of a behavioral measure in an important population, there are no true experimental treatments involved – the authors' purpose was to obtain a picture of climate negotiators' equity preferences.

Akpalu et al. (2017) conducted an experiment with African climate researchers and policymakers recruited from an environmental economics training workshop in Pretoria (see Chapter 5 in this volume). Twenty-four participants from 12 African countries took part in an experiment testing the effects of an emissions disclosure and rating rule modeled after a real-world program. Participants were randomly assigned to one of three groups: (1) a baseline group played 24 rounds of a public goods game in which players could retain carbon emissions (increasing their own individual payoff) or surrender them (increasing the group payoff); (2) a public disclosure condition in which each player's retained emissions are evaluated and made visible to the group after rounds 9–24; or (3) a disclosure-withdrawal condition in which emissions are disclosed after rounds 9–16 and not disclosed after rounds 17–24. The authors find some evidence that disclosure reduces emissions, but they note that, although the sample represents an important population, the small sample size means that effects are difficult to discern.

31.4.4 Next Steps

The primary aim of using economic games to study climate coordination is to discern behavioral patterns among people placed in representative scenarios, in the hopes of gaining insight into how the analogous climate actors may behave in the real-world situation. We can likely gain valuable insight from additional experimentation that models the crucial elements of the climate dilemma, holds uncontrollable factors fixed, and explores how various rules aid in reaching an international agreement.

Given that the aim is to create as close a representation of the real climate dilemma as a game setting allows, these games should be explicitly framed as pertaining to climate change, rather than hiding their purpose from participants. Gosnell and Tavoni provide an excellent model of a richly descriptive and informative game setting (Gosnell and Tavoni 2017, supplementary materials). Moreover, coordination experiments embedded in role-playing games could prove very informative. Green (2002) reports a study in which game theorists and research participants are asked to forecast the outcomes of six real conflict scenarios. Research participants assigned to role-play the disputes made correct predictions 64% of the time compared with the game theorists' 37% (and compared with 28% for research participants assigned to make predictions without role-playing).

Because the purpose of these games is to uncover general tendencies, recruiting climate-elite players may not necessarily provide much advantage over general population players (see Chapter 9 in this volume). When we are able to recruit climate elites to participate in a study (see Chapter 8 in this volume), we might gain more from simply asking them about the scenarios that the games are intended to represent. A survey experiment allows for more precision and nuance regarding the scenario, and – although behavioral measures are often more informative of preferences than are costless survey responses – the low stakes of an economic game seem unlikely to reveal tendencies that a climate elite would not voluntarily report. At the very least, a survey experiment gives the researcher precise control over the stimulus and reveals how a climate elite *believes* he or

she should behave in response – which can be informative in its own right.

The role of domestic public opinion and influences from other subnational actors appear likely to become increasingly important in international climate negotiations (Kline et al. 2018). These crucial aspects of the climate coordination problem have been understudied (Schneider 2018). The experimental literature could make an important contribution by incorporating these variables into climate coordination games and survey experiments of climate elites.

31.5 Moving Forward

Addressing climate change requires identifying climate actions that are both effective and politically feasible and coordinating international agreements that lead to global reductions in carbon emissions. Recent experiments studying climate beliefs, climate actions, and climate coordination have made important contributions toward these goals on several fronts. Experiments that prompt deeper engagement with climate information (e.g., revisiting one's own evaluation after exposure to others' evaluations, interacting with data, reflecting on frames and potential cognitive biases) show promise in moving people toward more accurate climate beliefs. Encouragingly, many of these treatments either exhibit the same effect regardless of ideology or even work to reduce the partisan divide in climate beliefs. While these findings make an important contribution, people are unlikely to spontaneously exhibit the same degree of engagement with climate information in everyday life, even if provided with the tools and opportunities to do so. And unfortunately, we have scant evidence, even within the laboratory setting, of how long these effects persist. Experiments focused on identifying what considerations, facts, or levers are able to trigger deeper scrutiny and evaluation in real-world settings – and produce lasting effects on climate beliefs – could make extremely important contributions.

Conjoint experiments identifying how different climate-policy attributes affect public support provide a useful tool to which policymakers should pay heed. Already, conjoint experiments have pointed to an unsurprising result: what people care about most when it comes to climate action is the cost. Future experimentation can most fruitfully contribute by focusing on what affects people's willingness to pay for the high costs of climate action. This might entail a coordinated agenda of conjoint experiments to home in on the most politically feasible policy designs, and framing experiments to identify what contextual considerations are most meaningful to various groups.

The most difficult problem in addressing climate change is arriving at some level of global coordination. As Levin et al. (2012) note, climate change has the characteristics of a super-wicked problem: (1) time is running out, and the problem is becoming more difficult to solve with each passing year; (2) the people seeking to provide a solution are also the ones causing the problem; (3) there is no central authority; and (4) due to (1)–(3), decisions reflect dangerously short time horizons, with extreme discounting of the future. Can experiments on climate coordination provide insights on how to deal with these features of the problem we face?

Economic games have been used to test how variations in rules or institutions affect the prospects for climate coordination, and some researchers have recruited climate elites to take part in such games. But many games studying climate coordination intentionally scrub any reference to climate change from their experimental setup.[10] Moving forward, more insight might be gained from experiments that take the opposite tack: richly descriptive game settings in which players are assigned specific country profiles and international relationships reflecting current reality and are tasked with making

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10 Testing whether randomly varying this aspect of the game could provide useful information. However, as mentioned above, if behavior does differ between two such designs, the question becomes which version more accurately reflects how climate actors would behave in the real world.

decisions from the perspective of a climate elite trying to arrive at a politically feasible and globally sustainable agreement. These coordination experiments should focus on identifying conditions that help players overcome the first three challenges of the super-wicked problem and avoid the extreme discounting of the future that we currently observe.

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