Climate change risk perceptions and the problem of scale: Evidence from cross-national survey experiments

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Abstract

This paper examines the concept of spatial optimism, defined as the tendency for individuals to perceive climate change as less threatening to themselves than to people in geographically more distant locations. Existing studies find mixed evidence of this phenomenon, while the methods employed often fail to rule out confounding factors. To resolve these empirical and methodological tensions, the paper presents results from a survey experiment fielded in nine countries spanning Europe, North America, and Asia. The survey finds that respondents systematically perceive climate change as a greater threat to the world than to themselves, in nine countries. However, while groups that may be considered more vulnerable to climate change often display higher levels of perceived overall risk, the survey finds evidence of spatial bias to be systematic across and within cases. Future research should apply this measurement strategy in more vulnerable countries and over time.

Keywords

Spatial optimism; construal-levels; survey experiment; climate change; question order effects; European internet panel study.

Data availability

The data that support the findings of this study are openly available at https://doi.org/10.7910/DVN/CRY5PU.

Introduction

Climate change is one of the greatest threats facing human civilization, yet less is being done to tackle it than recommended by most experts (Rogelj, Shindell, and Jiang 2018). One explanation for inaction is the perceived remoteness of the problem and its effects. Given that the buildup of greenhouse gases in the atmosphere is a relatively slow, cumulative process where atmospheric concentrations average out globally, it is difficult for non-experts to connect their everyday choices with the causes of global warming. Moreover, although climate change impacts are increasingly felt in the present, the consequences of a changing climate vary considerably and are difficult to quantify, with the greatest impacts most likely to occur in the future. These diffuse, uncertain and distant characteristics of the climate change issue suggest the phenomenon is abstract and difficult for people to experience directly.

The perceived distance of climate change is important because it could serve as a barrier to climate action: Why act to prevent a problem that is remote in space, time, or social context? Given that people often have a number of problems in their day-to-day life, resources are often prioritized toward tasks that are immediate and easy to comprehend. Indeed, the climate issue generally lacks salience, and is usually considered a lower priority compared to other issues, like health care and the economy (Lorenzoni and Pidgeon 2006; but see Yeager et al. 2011). This problem has led to the practical recommendation of 'proximizing' climate change, to make it more relevant and contextual to people's lives and thus purportedly enhancing personal and collective action. More recent studies suggest, however, that conservative and altruistic values, as well as feelings of fear and skepticism, interact with perceived distance and thus that the relationship between perceived remoteness and risk perception or policy support is more complex (Brügger, Morton, and Dessai 2016; Brügger and Pidgeon 2018).

While the implications of seeing climate change as a distant threat are under discussion, the phenomenon itself needs a more solid empirical investigation. Most studies pointing to such an effect involve single countries, unrepresentative samples, or methods that do not directly measure perceived proximity or remoteness of climate change. Mixed findings have also emerged in recent years, suggesting that members of the public worry about the effects of global warming both at a local and a global scale (Spence, Poortinga, and Pidgeon 2012; Brügger and Pidgeon 2018). Furthermore, we lack detail on what drives perceptions of distance related to climate change, and whether this phenomenon is homogeneous across countries. For example, different studies are open to alternative interpretations, as question order may affect results, as may reference to a particular geographical scale (Mason, Carlson, and Tourangeau 1994).

This paper presents the results of two original studies aimed at resolving these issues. We aim to answer the following research questions:

1. In the context of climate change, is spatial optimism a general phenomenon across countries and continents?
2. What explains variation in spatial optimism?
3. Does question order affect levels of measured spatial optimism?

Below, we discuss recent research on spatial optimism related to climate change. We then identify several pitfalls that are common in this literature before presenting data and results from two studies. Study 1 contains our nine-country survey experiment, which displays a relatively homogeneous spatial optimism effect. Study 2 examines question order effects related to climate change threat perception, finding that self-reported individual-level climate-related risk is lower

when preceded by a question about general risk. Finally, we discuss the results in our closing section including implications for future research and for policy.

Climate change and spatial optimism

The psychological distance of climate change has been studied along four theorized dimensions: temporal, social, and spatial distance, as well as uncertainty (Spence, Poortinga, and Pidgeon 2012). The conventional view in the literature states that people in general see climate change as a greater threat to people located far away than to themselves. This hypothesis is variously referred to as 'spatial bias', 'environmental hyperopia', and 'spatial optimism.' In this paper, we focus on the spatial dimension of psychological distance. We define spatial optimism as a tendency to perceive climate change as less threatening to oneself than to people in geographically more distant locations. We further assume that spatial optimism constitutes a property found at the individual level.

We have identified 22 articles in which a form of spatial optimism related to climate change is discussed. Most (about 17) present data from only a single country (Australia, Canada, France, Iran, Portugal, Spain, the US and the UK), while only a few are comparative. Within existing comparative work, Gifford et al. (2009) examine 18 countries; Schultz et al. (2014) look at 26 countries across two studies; Lorenzoni et al. (2006) include two; while Dunlap et al. (1993) examine 24 countries.

Our multinational, experimental approach to operationalizing spatial optimism is quite different from existing work. For instance, Brügger and Pidgeon (2018) use a qualitative approach (semi-structured interviews). Mir et al. (2016) base their question on a local (i.e., Tehran) and distant (i.e., Beijing) cue. In Spence et al. (2012) the distance condition is less

tangible because it refers to ‘areas that are far away from here.’ Some studies use experiments to test for a spatial effect. This is the case of Brügger et al. (2016) who present information in the form of text, and Wiest, Raymond, and Clawson (2015) who use videos.

A typical approach to measuring spatial optimism consists of first identifying an environmental problem and then asking respondents to choose threat levels across several scales, each corresponding to a geographical area. For example, Gifford et al. (2009) ask respondents to scale ‘the effects of greenhouse gases’ (q. 9) and other environmental problems in three locations: the respondent’s area, the respondent’s country, and globally, finding significant spatial optimism in 15 out of 18 countries. Another study of 375 randomly selected individuals from two French regions shows that survey respondents view the threat of climate change to the world as greater than to their home country and to themselves, in declining order (Fleury-Bahi 2008).

Leiserowitz (2006) asks US respondents to select which recipient of climate change impact they are most concerned about, offering the options of ‘you and your family’; ‘your local community’, ‘the US as a whole’; ‘people all over the world’; ‘non-human nature’; plus an option of selecting no climate change concern at all. Of these, 68% select either people all over the world or non-human nature, whereas only 13% point to themselves, their family, or their local community. In more recent work, Leiserowitz et al. (2019) consistently find that, relative to seeing personal risks from climate change, Americans are more likely to think others (e.g. future generations, ‘the world’s poor’, animals and plants) are more likely to be harmed by a changing climate.

Other studies are more comparative. For instance, an advantage of the Schultz et al. (2014) study is that it contains respondents in both developing and developed countries. The authors find a large degree of spatial optimism and suggest that this may be ‘a universal

psychological phenomenon' (288). Young respondents, people from smaller communities, and happier people, show greater spatial optimism.

The findings in the literature largely point toward a general existence of spatial optimism. However, the empirical record is not uniform. In a 2010 survey conducted in Great Britain, Spence, Poortinga, and Pidgeon (2012) asked participants to register their agreement or disagreement with the statements 'My local area is likely to be affected by climate change' and 'Climate change will mostly affect areas that are far away from here.' About 53% agreed with the former statement, while 49% agreed with the latter. Pointing to this relative balance in agreement with the two questions, the authors argue that 'climate change did not appear to be viewed as a primarily geographically distant phenomenon' (963). Supporting this finding, we have furthermore analyzed data on a similar pair of questions fielded in four countries – Germany, France, the UK, and Norway, in 2016, derived from the study *European Perceptions of Climate Change* (Steentjes et al. 2017). Here, 57% expressed agreement with the statement that 'climate change is likely to have a big impact on people like me.' The subsequent item in the survey, 'The impacts of climate change are mostly going to be felt in other countries,' garnered agreement among 61% of respondents across the four samples. The fact that the two questions gained essentially the same level of agreement suggests that a substantial share of respondents expect both local and global impacts, although the two statements in each pair do not clearly exclude each other (that is, climate change may affect local areas while affecting faraway areas more). A somewhat similar tendency is found in a World Bank (2010) study, which suggests that large proportions of citizens of 15 developing and developed countries see climate change as a threat to their own country.

Furthermore, recent research has challenged the notion that increased perceived proximity of climate change in itself motivates people to act. For example, Brügger and Pidgeon (2018) argue that conservative and self-enhancing individuals are more receptive to proximally framed messages, whereas altruistic and self-transcending individuals are more receptive to distant framings. Perceived distance may therefore trigger different mental processes in different individuals, which makes the relationship between perceived distance and willingness to act on climate change more complex than previously thought.

Overall, our study brings together two ideas in the literature in a way that has not been done before: we do not ask the same person to report risk perceptions at different levels (we randomize this); and we ask a general risk perception question thought to capture the underlying, latent construct (Kahan 2016). We further speculate that spatial optimism is likely to be less pronounced among population segments that are more vulnerable to climate change (e.g., youth and coastal populations).

Design challenges when measuring spatial optimism

While a majority of the findings in the literature point toward the existence of spatial optimism in most countries, a number of methodological issues raise doubts about the robustness and magnitudes of the findings. Such issues include potential context effects, respondent fatigue, and question wording.

Of these, context effects of various types (Tourangeau et al. 1989) constitute perhaps the greatest challenge. Specifically, surveys that ask the same individuals to rate both proximate and distant environmental problems in the same setting may produce contrasts between the proximate and distant evaluation that are either too large or too small. That is, respondents may feel inclined

or obligated to make the responses to the two items similar to each other, or alternatively, may feel a need to produce a contrast.

Consistency bias could lead to estimates that are smaller than what the perceived difference would have been if respondents were asked questions about each of the geographical conditions in an isolated setting. This could for example take the form of anchoring (Tversky and Kahneman 1974), where the response to one item influences the set of what the survey participant sees as reasonable responses to the next. This has also been referred to as an assimilation effect in surveys, whereby responses to later items are moved in the direction of consistency with previous responses (Mason, Carlson, and Tourangeau 1994).

Conversely, participants may feel a desire or need to emphasize differences when thinking comparatively about risks at different scales, which could produce estimates that are greater than the difference measured in the absence of such a context. Such a contrast effect may in part be induced by respondents' unwillingness to repeat themselves in surveys, which forms part of the normal rules of conversation. Experimental evidence has shown that contrast effects emerge in settings where two questions related to the same topic at two different scales are asked and when the question about the specific setting (such as a local community) precedes the question relating to a more general setting (such as a state). Specifically, 'respondents appear to exclude certain considerations relevant to the general (state) question when the general question comes second and when these same considerations had provided the basis for the previous rating' (Mason, Carlson, and Tourangeau 1994: 576). This suggests that asking respondents to assess the threat of climate change to themselves first and to the world last could lead to information related to the personal question being subtracted from the assessment related to the world as a whole, thus producing a bias that could in part account for observed spatial optimism.

Finally, survey length and resulting respondent fatigue may increase the likelihood of participants responding more according to response styles such as acquiescence, mid-point, and random response rather than making an effort to reveal their true opinion on each question (Kieruj and Moors 2013; Van Vaerenbergh and Thomas 2013). Questionnaire batteries where respondents are tasked with evaluating several versions of the same question (e.g., evaluating climate change threat on a personal, local, national, continental, and world scale) may produce respondent fatigue and reduce the quality of the results. Batteries of structurally similar questions and response options, as used in several of the spatial bias studies listed above, may be particularly susceptible to non-differentiating questions due to satisficing (Krosnick 1999).

Survey experimental designs offer a solution to these multiple problems. Rather than posing many questions to each individual, this design increases the number of individuals but poses only one question to each. This design eliminates the potential problems of assimilation and contrast effects. It also reduces fatigue, as each respondent receives only one question related to the topic. In addition, it facilitates the use of an unmarked control condition, in the current case a question asking about the threat posed by climate change in general, with no place or target indicated.

Hypotheses

From our reading of the literature, we develop and test the following hypotheses:

- H_1: *Spatial optimism is observable across countries, with personal risk perception levels systematically lower than perceived risk accruing to other people and places.*
- H_2: *Spatial optimism is smaller for individuals that have more to lose from climate change, such as fishers/farmers, the young, coastal residents and families with children.*
- H_3: *Question order affects reported personal and general perceived risk.*

Analysis

Our empirical analysis draws on two studies. Study 1 is our main empirical contribution where we present our nine-country study and demonstrate the consistency of spatial optimism across countries (H_1) and across selected sub-samples within countries (H_2). Study 2 uses data from the Norwegian Citizen Panel to test the predictions that question order affects measures of spatial optimism (H_3).

Study 1: Multi-country survey experiments

Survey design

We employ survey experiments across nine countries to estimate the effects of spatial distance on climate change threat perception. That is, we ask broadly similar questions to all respondents, only varying two or three words in each case, thus producing different treatments designed to uncover latent spatial optimism. Before the survey administration in the European countries, each respondent was randomly assigned to one of five sub-samples, four of which carried a distance marker (the treatment) and the fifth constituting a control group with no reference to the object of harm. The distance markers had the following values:

[*blank* / to you personally / to **PANEL COUNTRY** / to Europe / to the world]

In the Canadian, Taiwanese and US surveys, the experimental conditions were changed so that 'Europe' was omitted. Owing to the importance of regional cleavages in Canada (Mildenberger et al. 2016), the Canadian experiment also included an experimental condition that asked about the

threat of climate change to their province. In the survey, each respondent received one single question related to the current experiment, taking the following form:

‘To what extent do you see climate change as a threat [¡distance]?’

Here, the [¡distance] element expressed one of the distance markers (experimental conditions) listed above. For example, a respondent in the Netherlands would receive one of the following questions, randomly assigned:

1. ‘To what extent do you see climate change as a threat?’
2. ‘To what extent do you see climate change as a threat to you personally?’
3. ‘To what extent do you see climate change as a threat to the Netherlands?’
4. ‘To what extent do you see climate change as a threat to Europe?’
5. ‘To what extent do you see climate change as a threat to the world?’

The response scale took eleven values, from ‘0 – No threat at all’ to ‘10 – Extreme threat.’ This eleven-point risk perception measure has been used in previous research (Kahan et al. 2012; Jones 2014). While this measurement strategy is somewhat at odds with the more common practice of using fewer and fully labeled response options, the 0-10 format increases portability across cultures as it reduces the risk of bias created by translation. Furthermore, the simplicity of this instrument makes it suitable also for telephone surveys, which are typically more restricted as regards the number of words that may be used in questions and response options. The 0-10 format also reduces a potential source of bias from mode effects, as people intuitively know zero

is low, five is a mid-point, and ten is high. Since this study is composed of telephone and web samples, this advantage is particularly important; likewise, this design facilitates future study

[TABLE 1 ABOUT HERE]

using the same design. On the telephone, respondents were asked to indicate, 'On a scale from 0 to 10, with 0 being no threat at all and 10 being an extreme threat, to what extent do you see climate change as a threat [¡distance]?' On the web, a similar question stem was used, and only the end points of the scale were labeled as 'no threat at all' and 'extreme threat,' with the remaining levels marked by numbers only.

The resulting data from this experiment thus consist of one treatment variable displaying the randomly assigned experimental condition and one outcome variable expressing the respondent's perceived threat level given the experimental condition.

Cross-national survey data collection

The data were collected in online or telephone surveys in nine countries between May 2017 and May 2018. Six of the country surveys were coordinated as part of the European Internet Panel Study's joint questionnaire (Arnesen 2018). See Appendix B for more information on the studies. The three non-European studies were conducted by telephone. Table 2 displays the participating countries, survey mode, fielding dates, and sample size.

Although the nine countries in our study are characterized by relatively high levels of development, we believe they are sufficiently heterogeneous to say something about the robustness of the results while looking at how macro-level differences across cases might

condition results. For instance, large differences in population size across our cases allow us to explore the idea that climate change vulnerability and socio-political cultures might condition the effects of spatial distance. First, respondents in smaller countries such as Iceland might view climate change as less of a threat for their country than respondents in larger countries, as more people may potentially be harmed by climate change in a larger country (e.g., the US). Second, the selected countries differ on cultural dimensions as well. Beyond important differences in climate change attitudes across Canada and the US (Lachapelle, Borick, and Rabe 2012), the US and the Nordic countries are often seen as opposing poles in terms of conservativism and altruism, and these values can potentially make people more likely to think of climate change as a more or less distant problem (Brügger and Pidgeon 2018). Finally, the US and Taiwan are more exposed to dangerous extreme weather events than the remaining sample (Ricke et al. 2018), which could make respondents in these countries more concerned with proximal climate change. Estimating effects with this group of countries may therefore be a strong indication of robustness across different contexts.

Results

Figure 1 plots mean threat perceptions for each version of the question asked across the nine countries in the sample. The whiskers identify the 95% confidence interval. As shown in Figure 1, risk perceptions in the control condition are roughly similar across all countries, at about seven on the 0—10 threat perception scale. Risk perceptions in Canada and the United States are somewhat lower in this untreated distance condition, however. Moreover, we see a generally linear increase in threat perception as distance increases from ‘personal’ to ‘world’ in all countries, though in some, the differences across the entire range of experimental groups are more modest (e.g., Canada) while in others the differences are more pronounced (e.g. Germany).

This provides new, experimental evidence that people in wealthy, industrial countries on average perceive climate change as a greater threat to faraway places than to themselves.

What is the size of this effect? In the US case, the greatest contrast, between 'you personally' and 'the world,' amounts to 1.6 units on the 0-10 scale, or about one-half of the standard deviation of the threat variable (SD = 3.1, see Table 3 in Appendix A for detailed numbers). In France, the greatest contrast is 1.3, or just over half of the standard deviation on the threat variable (SD = 2.3). There is thus a clear and systematic, though modest, effect found in all countries.

[FIGURE 1 ABOUT HERE]

Further, the threat level associated with the unmarked control condition in Figure 1 is in all cases closer either to that of the perceived threat to the world or to the respondent's country, than to the respondent herself. Specifically, the point estimate of the 'world' treatment is closest to the control condition in all the European countries, whereas threat perception for the target country is closer to the control condition for the Asian and North American cases. At least in Europe this provides additional, indirect evidence of spatial optimism, as the perceived threat of climate change in general (the control condition) is numerically closer to the perceived threat of climate change to the geographical entity furthest away. These results are thus consistent with H_1.

Within-country variation

The spatial optimism shown so far may reflect rational considerations about one's likelihood of being affected by climate change in a wealthy country. However, exposure to the effects of climate change are not uniform within countries. Here we address the possibility that spatial

optimism is weaker for individuals that have more to lose from climate change, such as fishers/farmers, coastal residents, younger respondents, and families with children (H_2). Since our surveys were fielded as parts of various independent studies, relevant co-variates are not harmonized, leading us to address this hypothesis using the most appropriate data from selected countries. This approach will thus not produce a comprehensive test of H_2, but rather explorations to prepare the ground for future studies.

Both Norwegian and Taiwanese data allow us to examine whether occupation, age, income or parenthood affect spatial optimism. Specifically, we may expect that farmers, foresters and fishers may consider themselves more vulnerable to climate change personally, as they and their livelihoods may be more exposed to extreme weather including droughts and storms. Low-income people may also feel more exposed to proximate effects of climate change, as may younger respondents. Finally, parents may feel vicariously threatened by climate change on behalf of children living at home with them. All these groups may thus be reasonably expected to display lower degrees of spatial optimism.

Figure 2 displays the results for these variables, comparing the groups to the rest of the population, or in the case of low-income people, to high-income people.[1] Overall, there are few significant differences between the groups within each panel. In Norway, low-income people report somewhat elevated threat levels for the 'personal' and the unmarked categories, but the

[1] We use personal, not household income. In Norway, low income is defined as NOK 300,000 or less. In Taiwan, low income is defined as 400,000 yuan or less. Furthermore, we use household size as proxy for children living at home in Taiwan, assuming that households with more than two persons include children. Young people are defined as those born in 1990 or later. In Norway, farmers and fishers count 43 out of 1,483 respondents; in Taiwan, the number is 73 out of 2,011.

differences are not statistically significant. In Taiwan, perhaps the most striking difference is seen in the fact that farmers and fishers report lower threat levels in the control condition, but given the relatively low number of individuals in this category (n=73), it is necessary to exercise caution before making inferences. Overall, these tests display little support for H_2 as groups presumed to be more vulnerable do not show distinctly lower levels of spatial optimism.

Coastal vs. non-coastal residence may be a major determinant of variation in spatial optimism, as living close to the coast implies greater proximate risk of adverse effects from sea-level rise, which could translate into lower spatial optimism. Both Norway and Taiwan are mostly coastal and cannot provide a test of this hypothesis. However, it can be shown from Canadian and US data that no clear pattern of spatial optimism emerges based on coastal vs. non-coastal residence, although risks associated with the provincial level in coastal Canadian provinces are somewhat elevated (see Supplementary Information, Figures S1 and S2).

[FIGURE 2 ABOUT HERE]

Across-country variation

There is some evidence that spatial optimism associates negatively with actual vulnerability to climate change at the country level. For example, the social cost of carbon – that is, the marginal additional damage caused by one extra ton of carbon dioxide emissions – has recently been calculated at the country level, with the result that the US and Taiwan face higher costs than the other seven countries in the sample (Ricke et al. 2018). The effect of mentioning the threat 'to Taiwan' is statistically indistinguishable from the control condition in the country (95% CI [-.33, .18]). Mentioning threat 'to the US' yields a higher point estimate by about half a point, but this

remains statistically insignificant (95% CI [-.22, 1.1]). Overall, our results are consistent with the relatively low social cost of carbon estimated for the six European countries.

Does the variation in perceived threat levels to the respondent's country also vary with population size? To the extent that risk perceptions may be shaped by perceptions of potential harm in terms of absolute numbers of lives lost, respondents in large countries may conceivably feel that the risk facing their country is greater given that more people may be affected by climate change than in a smaller country, all else equal. We do indeed find that the differential between perceived threat to the respondent's country and the unmarked control condition correlates to some extent with population sizes (Pearson's r = .64). The United States, Canada, and Taiwan show higher effects of 'country' than the rest. Yet, Germany and France are more populous countries than Canada and Taiwan, and the Netherlands for instance displays a significantly higher effect of the 'country' treatment than Germany. It therefore seems unlikely that the differences in risk perceptions between 'personal' and 'world' is an artifact of more people harmed on a global scale. Altogether, we thus interpret the results to be relatively similar across countries, which lends robustness to our findings related to H_1, but challenges the plausibility of H_2.

Study 2: Question Order Effects

Here we present data from an experiment fielded in Wave 14 of the Norwegian Citizen Panel (NCP), an Internet-based, probability-sample survey research infrastructure hosted by the University of Bergen and used exclusively for academic research. The data collection took place from 15 January to 11 February, 2019. Each respondent received the same two questions but in randomized order. The question wordings are the following:

‘How serious is climate change as a threat to you personally?’

‘How serious is climate change as a threat in general?’[2]

Participants in each case selected a response from a five-point scale ranging from ‘not a threat’ (1) to ‘very serious’ (5).

[TABLE 2 ABOUT HERE]

Overall, the mean response given to the ‘threat to you personally’ question is roughly one full point greater than the mean score associated with the ‘general’ threat perception wording, which is in line with the spatial optimism found in Study 1.

More to the point, the evidence supports the hypothesis that question order matters (H_3). Notably, the average personal threat level is slightly higher when the ‘personal’ question comes before the ‘general’ question. By contrast, the average reported ‘general’ threat level is unaffected by question order.

This context effect differs from the one identified by Mason, Carlson, and Tourangeau (1994), who found that respondents exclude certain aspects relevant to the evaluation of a general question when a similar, personally framed question comes first. In our case, the response to the personally framed question changes when the more general question comes first. One reason for this difference may be that respondents have more clearly defined views of climate change risks

[2] Original Norwegian wordings are: “Hvor alvorlig trussel er klimaendringer for deg personlig?” and “Hvor alvorlig trussel er klimaendringer samlet sett?”

as defined at the general or global level, while their views about climate change-induced threats to themselves personally are less clear and thus more susceptible to change depending on context. This contrasts to the cases of US community and state economies in Mason, Carlson, and Tourangeau (1994), where respondents may have had a better grasp of their local conditions than the more abstract state economies of Oregon and Idaho.

In the end, this question order effect is not very large, only about one-sixth of the spatial optimism found in the contrast between the 'personal' and 'general' perceived risk levels. Nevertheless, this result indicates that researchers should be conscious of potential context effects when asking several structurally similar questions in a row. For climate change-related studies, if an experimental design is not feasible or desirable, the recommendation derived from this finding would be to ask questions related to the individual before questions related to the whole, as for example done by Steentjes et al. (2017).

Discussion and conclusion

This paper provides the most systematic evidence to date of spatial optimism with respect to climate change threat perceptions. Besides producing new, survey experimental data on spatial optimism across three continents, the present study addresses some methodological problems and limitations of earlier studies, notably by addressing concerns about context effects potentially affecting the results. It also raises a number of implications for research and practice around public engagement with climate change.

We began (Study 1) by presenting and testing our survey instrument. Consistent with H_1, we find significant spatial optimism across all countries. Notably, perceived threats to respondents themselves are seen as significantly lower than perceived threats to their home countries and to the world. Furthermore, threat levels associated with the control condition,

which had no spatial information, were closest to threat levels associated with the experimental treatment mentioning 'the world' (for the European countries) or the respondent's country (for the North American and Asian countries). Spatial optimism is robust and relatively uniform across countries.

Given that our sample consists of developed countries with relatively high state and private capacities for climate change adaptation, including insurance markets, spatial optimism does not appear unreasonable or irrational. Climate change most likely constitutes a greater threat to people who do not live in the nine countries included in this study. At the same time, there may be reasons to expect more severe impacts of climate change in given areas (e.g., coastal) and on given demographic groups (low-income people; farmers/fishers; youth). We thus hypothesized that spatial optimism would be lower among groups assumed to be more vulnerable to climate change within their own country context (H_2).

Given that our survey experiments were fielded as part of many different studies, we did not have one harmonized way to test hypotheses about such heterogeneous treatment effects. Instead, we ran some tests for heterogeneous effects on selected variables in a subset of countries, leaving a more systematic investigation for future research. These tests produced inconclusive results that cannot reasonably be said to support H_2.

In terms of effect size, this study has shown that reported threat levels increase by roughly two steps on a 0-10 scale as the object of the assessed threat moves from the individual respondent to 'the world'. While statistically significant in all cases, this is not an extremely large effect. The fact that threats to individual respondents are seen as lower than threats to the world thus does not exclude a sense that climate change also poses risks to one's immediate surroundings.

Finally, we presented evidence of context effects in survey questions about climate change at different scales (H_3). Specifically, our results suggest that individuals introduce a contrast effect, slightly widening the risk perception difference between general and personal risk, when the question about general risk is asked first. General risk perceptions, on the other hand, remain unaffected by question ordering in our experiment. This suggests that public assessments of general climate change-related risk are more robust than assessments of risk related to the personal level.

These results have several implications for research and policy. From a practical standpoint, a key message is that the spatial optimism found in previous studies appears to be relatively consistent across the countries examined in this study, and robust when using the measurement strategy developed here. This would suggest that climate change communication might be more effective when emphasizing the local threats facing individuals here and now, as a way of generating a sense of urgency and mobilizing public support. Indeed, past research consistently finds that heightened risk perceptions help predict support for climate action and self-reported willingness to adopt general behavioral change (Leiserowitz 2006; Krosnick et al. 2006; Stoutenborough, Bromley-Trujillo, and Vedlitz 2014). An alternative interpretation of our results might suggest that actors seeking to generate support for climate policies should focus on communicating the negative consequences of climate change happening around the world, since this is the scale at which individuals tend to see the highest threat levels. While the data here do not allow us to adjudicate between these approaches, results suggest that the spatial risk perception gap is perhaps not as large as might be assumed, and may in fact be decreasing over time. We also know that, on its own, a sense of urgency – regardless of its origins – may be insufficient if it is not accompanied by a sense of agency and self-efficacy (Mayer and Smith

2018). The challenge of communicating the risks of climate change is thus not just a question of which risks to communicate, but also one of balancing a sense of urgency and hope.

From a research perspective, this study proposes and tests a new measure of spatial optimism in climate change risk perception. We find that people across nine countries see climate change as a greater threat to the world than to themselves, with intermediary entities such as their country, province, and continent falling between these extremes. With increasing occurrence of extreme weather events and the onset of sea-level rise in wealthier countries, this gradient may decrease. Indeed, a re-run of our Norwegian experiment after the unusually dry summer of 2018 among the same respondents shows significantly increased perceived threats to Norway and to the world, and in the control condition, but no change in the personal and European treatment conditions (Supplementary Figure S3). Future survey experiments should therefore replicate this experiment to look for secular changes in spatial optimism over time. Another important line of research would be to replicate this study in other parts of the world not examined here. Indeed, we know from previous research that climate change risk perceptions tend to be higher in developing countries (Sandvik 2008; Lee et al. 2015); there is also evidence that this holds for environmental problems more generally (Dunlap, Gallup Jr, and Gallup 1993). Consequently, future research may wish to examine these dynamics in the developing world where the risks of climate change are more acute.

Our measure is particularly well suited for cross-country comparison, as it controls for country-specific effects such as language and political culture, distilling only the experimentally derived spatial optimism level. This measure may then be directly compared across countries. Thus, for example, while US respondents predictably display low absolute levels of risk perception compared to the other countries in our study, American respondents also display the

lowest level of spatial optimism on behalf of the US. This suggests that perceptions of national-level climate risks in the US may be higher than previously thought, a potentially important hypothesis that merits further research.

At the same time, the concept of spatial optimism may need more disaggregation, as perceived threat levels for specific sub-populations do not always move smoothly or even monotonously upward from nearer to more remote spatial designations. Instead, specific conditions or events may increase perceived risks for some defined places even as risks to individuals do not move, as seen in the cases of Canadian coastal provinces (Figure S1) and Norway over time (Figure S3). These complications are in line with recent findings that personalized risk information may not increase (and may even reduce) perceived risk to individuals from climate change (Mildenberger, Lubell, and Hummel 2019). This suggests that communication efforts may be more effective when emphasizing risks at the level of the province, or the national level, rather than focusing on individual-level risk.

In sum, we provide a new approach for measuring the impact of geographic proximity on perceived threat of climate change and invite more work in this area. We note that this measure is not intended as a substitute for multi-item risk perception measures but is designed for a specific purpose; namely, to measure the size of the spatial gaps in climate change risk perceptions. Such gaps are considered an important part of the reason why engagement with climate change lags considerably behind self-reported levels of concern, but differences between levels may have more complex explanations than previously thought.

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Appendix A: Data underlying Figure 1

	NOR	**ICE**	**SWE**	**NLD**	**FRA**	**DEU**	**USA**	**CAN**	**TWN**
	b	b	b	b	b	b	b	b	b
	(se)	(se)	(se)	(se)	(se)	(se)	(se)	(se)	(se)
	[95% CI]	[95% CI]	[95% CI]	[95% CI]	[95% CI]	[95% CI]	[95% CI]	[95% CI]	[95% CI]
	Cohen's D	Cohen's D	Cohen's D	Cohen's D	Cohen's D	Cohen's D	Cohen's D	Cohen's D	Cohen's D
Personal	-1.63***	-1.60***	-2.03***	-1.50***	-1.30***	-1.61***	-0.68*	-0.72*	-0.76***
	(0.15)	(0.16)	(0.14)	(0.09)	(0.14)	(0.15)	(0.34)	(0.26)	(0.13)
	[-1.93,-1.34]	[-1.91,-1.29]	[-2.31,-1.75]	[-1.67,-1.32]	[-1.58,-1.01]	[-1.90,-1.32]	[-1.35,-0.02]	[-1.23,-0.20]	[-1.02,-0.51]
	-0.65	-0.66	-0.87	-0.68	-0.56	-0.64	-0.23	-0.27	-0.36
Country	-0.56***	-0.91***	-0.97***	-0.52***	-0.85***	-1.01***	0.44	0.10	-0.08
	(0.15)	(0.16)	(0.14)	(0.09)	(0.14)	(0.15)	(0.34)	(0.26)	(0.13)
	[-0.85,-0.27]	[-1.22,-0.60]	[-1.24,-0.70]	[-0.69,-0.34]	[-1.13,-0.57]	[-1.29,-0.72]	[-0.22,1.10]	[-0.41,0.62]	[-0.33,0.18]
	-0.24	-0.41	-0.45	-0.25	-0.39	-0.42	0.14	0.04	-0.04
Europe/Canadian province	-0.25	-0.17	-0.42*	-0.47***	-0.81***	-0.50***		-0.30	
	(0.15)	(0.16)	(0.14)	(0.09)	(0.14)	(0.15)		(0.27)	
	[-0.54,0.04]	[-0.48,0.15]	[-0.69,-0.14]	[-0.65,-0.29]	[-1.10,-0.53]	[-0.79,-0.21]		[-0.82,0.22]	
	-0.11	-0.08	-0.20	-0.23	-0.35	-0.21		-0.11	
World	0.16	0.26	0.14	0.18*	0.00	0.32*	0.86*	0.21	0.66***
	(0.15)	(0.16)	(0.14)	(0.09)	(0.15)	(0.15)	(0.34)	(0.27)	(0.13)
	[-0.13,0.45]	[-0.05,0.57]	[-0.13,0.41]	[0.01,0.36]	[-0.29,0.29]	[0.04,0.61]	[0.21,1.52]	[-0.31,0.74]	[0.40,0.92]
	0.07	0.12	0.07	0.09	0.00	0.14	0.29	.08	0.32
AIC	12338.25	8835.02	10832.14	23872.80	11202.64	12386.41	3347.07	4685.89	8646.21
R^2	0.07	0.09	0.11	0.07	0.05	0.08	0.03	0.02	0.05
N	2674	1988	2458	5506	2494	2692	658	980	2011

Table 3: Effects of distance on climate change threat perception

The table shows the numbers underlying Figure 1, summarizing outputs from ANOVA models with distance treatment groups as the independent variable and perceived threat as the dependent variable, run separately for each country. The mean estimates are expressed relative to the reference distance group (‘blank,’ i.e., no distance entity mentioned).

* p<.05, ** p<.001, *** p<.001

Appendix B: Data collection

The **Canadian** survey was conducted via a random digit dialing (RDD) telephone survey with a disproportionate stratified sample of 1,000 Canadian residents, aged 18 years of age and older. An overlapping dual-frame (landline and cell phone) sample was used. Quotas were set to ensure that 400 surveys were conducted with respondents via cell phones and 600 with those on landline. Elemental Data Collection, a survey-fielding house located in Ottawa, Canada, conducted the survey using its Computer Aided Telephone Interviewing (CATI) system. Interviews were conducted between 7 May to 13 May 2018, in both official languages (i.e. English and French), and averaged 4.4 minutes in duration. With a random probability sample of this size, results can be considered accurate to within +/- 3.1%, at a 95% level of confidence. The response rate for this survey as calculated using the American Association of Public Opinion Research (AAPOR) RRII formula is 9%.

The University of Bergen was responsible for the **Norwegian** part of the study. The data were collected using the Internet-based Norwegian Citizen Panel, in its ninth wave of 11 May – 6 June, 2017. Panel members were recruited via random draws from the Norwegian Population Register provided by the Norwegian Tax Agency. The most recent recruitment was done in Wave 9. Each selected person received a postal invitation with a code for logging on to the service. The participants were offered an incentive in the form of entering a draw of a travel gift card worth NOK 25,000 (about EUR 2,700).

The **Taiwanese** survey was conducted during Nov. 20 - Dec. 2, 2017, using computer assisted telephone interview (CATI). A total of 2011 interviews were completed and the success response rate was 65%. Interviewees' concern on telecom fraud has affected our survey response rate. Stratified random sampling was used in our survey, where Taiwan (excluding offshore

islands) was stratified into 19 strata according to administrative divisions of cities and counties. The survey target is the residents of Taiwan who were at 18 years or older. The random sample from each stratum is taken in a number proportional to the distribution of targeted population in the latest census (completed in September 2017). We performed chi-squared test (0.37), which shows that our stratified samples are not statistically different from the entire population (95% confidence interval).

The **United States** survey was conducted via telephone with 751 adult (age 18 or older) residents of the United States between April 29 and May 25, 2018 as part of the National Surveys on Energy and the Environment (NSEE) from the University of Michigan and Muhlenberg College. Respondents were interviewed in English on both land lines (146) and cell phones (605) by the staff of the Muhlenberg College Institute of Public Opinion (MCIPO) in Allentown, Pennsylvania on the Institute's Computer Aided Telephone Interviewing (CATI) system. With a randomly selected sample of 751 respondents the margin of error for the surveys is +/- 4% at a 95% level of confidence. The sample data has been weighted by gender, race, age, income and educational attainment to reflect those population characteristics of the United States as reported by the United States Census Bureau for 2016. The calculation of sampling error takes into account design effects due to the weighting identified above. In order to reach a representative sample of Americans both land lines and cell phones are called up to 5 times. The response rate for this survey as calculated using the American Association of Public Opinion Research (AAPOR) RRII formula is 8%.

For the five other European Internet Panel Study countries, see overall and individual country documentation reports (Blom et al. 2018; Arnesen et al. 2017; Einarsson and Jónsdóttir 2017; Das et al. 2017; Martinsson et al. 2018; Arnesen 2018).

Tables

Country	Mode	Start	End	N	EIPS
France	Internet	12-Jul-2017	28-Sep-2017	2,507	Y
Norway	Internet	11-May-2017	6-Jun-2017	2,706	Y
Iceland	Internet	16-May-2017	6-Jun-2017	2,205	Y
Germany	Internet	01-May-2017	31-May-2017	2,702	Y
Netherlands	Internet	15-May-2017	14-Jun-2017	5,622	Y
Sweden	Internet	12-Dec-2017	10-Jan-2018	2,507	Y
Taiwan	Telephone	20-Nov-2017	2-Dec-2017	2,011	N
US	Telephone	29-Apr-2018	25-May-2018	751	N
Canada	Telephone	7-May-2018	13-May-2018	1,000	N

Table 1: Fielding overview

The study was conducted fully over the Internet in the European countries and by phone in the remaining three countries.

	General then personal	Personal then general	Difference
Threat to you personally	3.00 [2.94 , 3.06] 1,079	**3.16** [3.10 , 3.23] 1,139	-.159 [-.249 , -.0686] t=-3.45; p < .01
Threat in general	**4.09** [4.03 , 4.15] 1,085	4.07 [4.01 , 4.13] 1,137	.0199 [-.0600 , .0999] t=.489; n.s.

Table 2: Average perceived threat levels, Norwegian Citizen Panel, 2019.

The numbers show average reported threat level, where 1 is the minimum and 5 the maximum. Confidence intervals (95%) around the mean are given in square brackets, followed by number of observations. The significance levels are calculated using t-tests. For ease of reading, numbers in bold indicate the average responses for the questions when they were asked first.

Figures

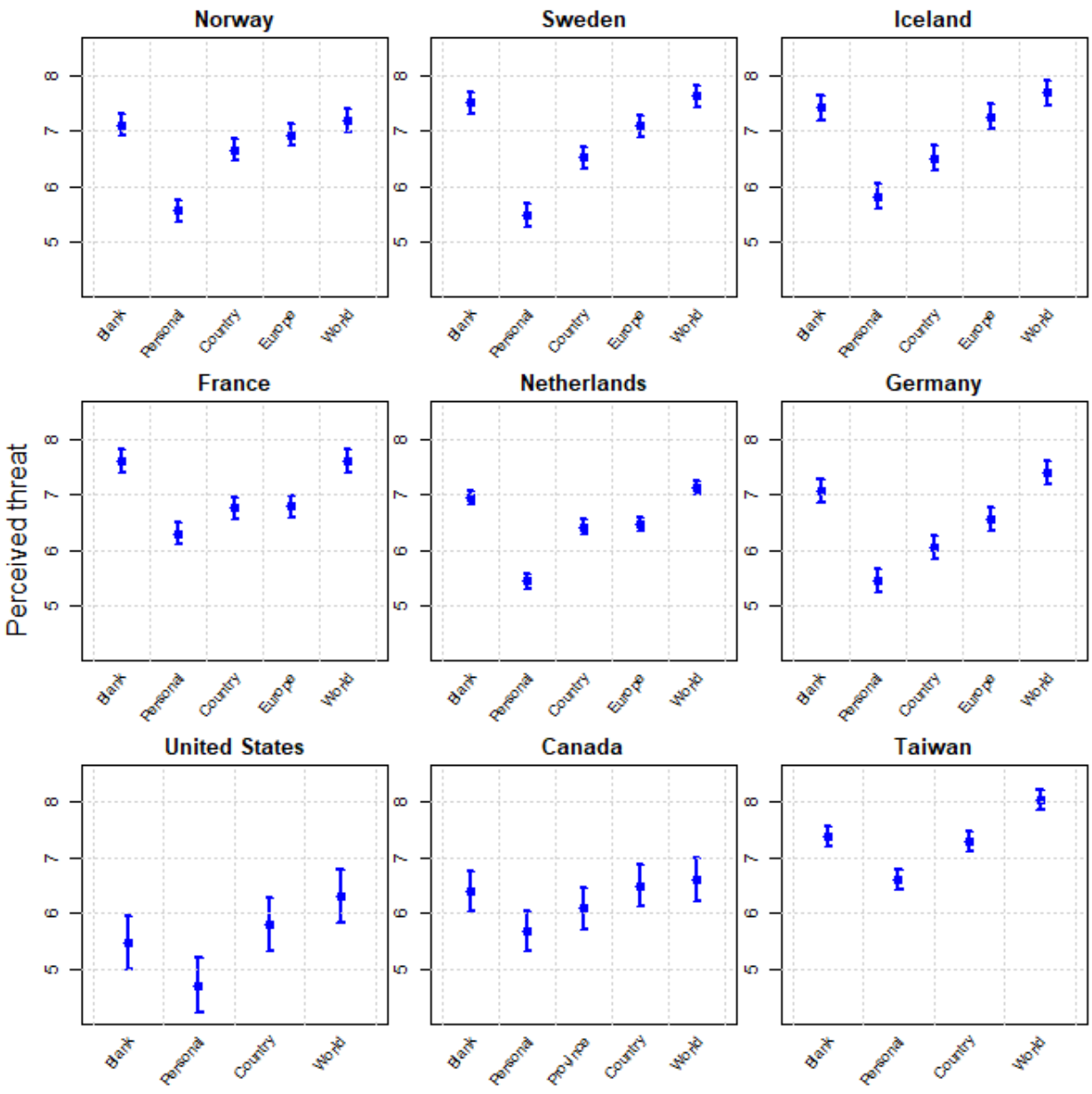

Figure 1: Effects of distance on climate change threat perception.

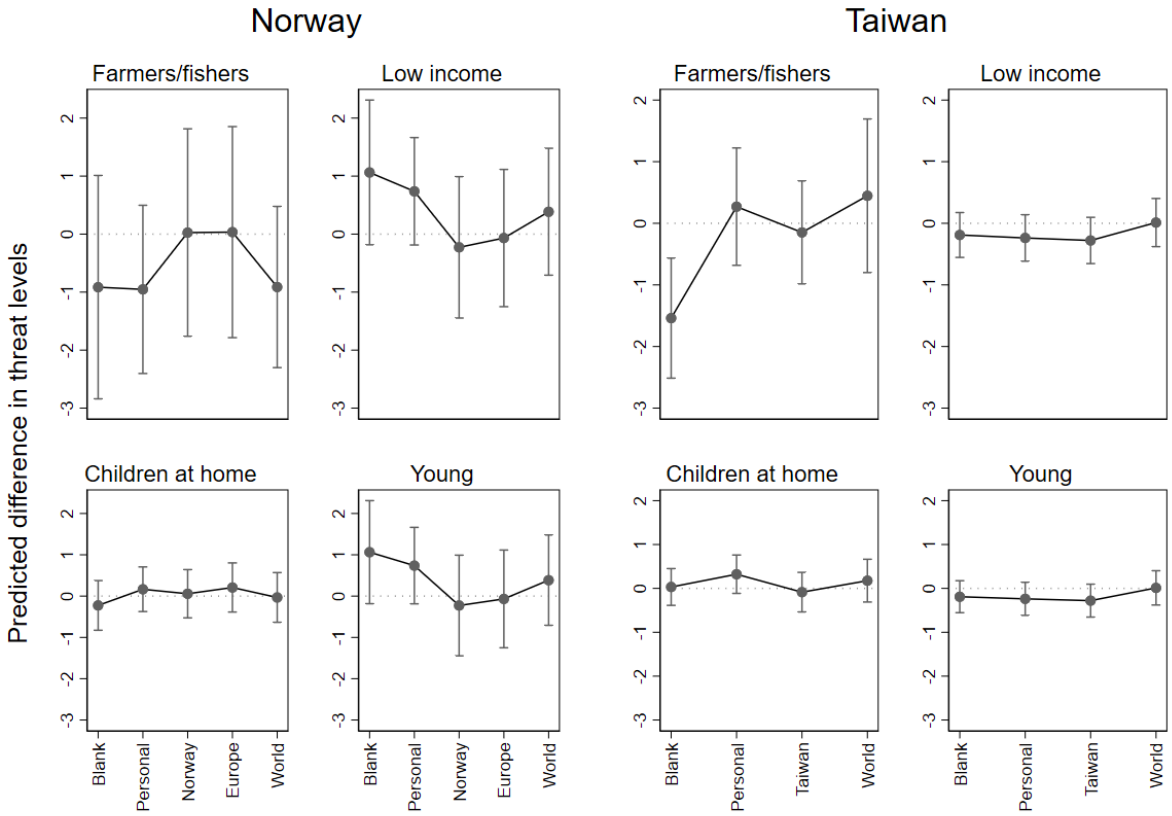

Figure 2: Test for heterogeneous effects of distance treatment in Norway and Taiwan

Figure captions

Figure 1: Effects of distance on climate change threat perception.

The figure shows estimated mean levels of reported threat perceptions and their 95% confidence intervals on a 0-10 scale. The estimates are based on ANOVA models with distance treatment groups as the dependent variable, run separately for each country. We also present model outputs in Table 3 in Appendix A. The supplementary materials (Tables S1-S5) include robustness tests where we estimate the treatment effects with seemingly unrelated regression to account for the different variances of means across countries, and we include various corrections for our high number of hypotheses (e.g., Bonferroni adjustment). We also report balance tests and weighted

and unweighted results for the five countries where weights are available. Overall, the robustness tests provide the same results as in this figure.

Figure 2: Test for heterogeneous effects of distance treatment in Norway and Taiwan

The figures show the results of the same ordinary least squares regression analysis in each country, with perceived threat level as the dependent variable, binary variables representing the experimental treatments, binary variables representing farm/fishery employment, income level, the presence of children at home and young age, as well as interaction terms between these variables. The number of observations in the regression models was 1,462 for Norway and 1,964 for Taiwan.