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Making behavioral science integral to climate science and action

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Abstract: The behavioral sciences were there at the beginning of the systematic study of climate change. However, in the ensuing quarter century, they largely faded from view, during which time public discourse and policy evolved without them. That disengagement and the recent reengagement suggest lessons for the future role of the behavioral sciences in climate science and policy. Looking forward, the greatest promise lies in projects that make behavioral science integral to climate science by: (1) translating behavioral results into the quantitative estimates that climate analyses need; (2) making climate research more relevant to climate-related decisions; and (3) treating the analytical process as a behavioral enterprise, potentially subject to imperfection and improvement. Such collaborations could afford the behavioral sciences more central roles in setting climate-related policies, as well as implementing them. They require, and may motivate, changes in academic priorities.

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A historic opportunity

In 1979, the then-new US Department of Energy (DOE) commissioned the American Association for the Advancement of Science (AAAS) to help develop a 20-year plan for its Carbon Dioxide Effects Research and Assessment Program. That effort produced a research agenda (US Department of Energy, 1980a) and a supporting workshop summary (US Department of Energy, 1980b). Even then, it was clear that "The probable outcome is beyond human experience" (US Department of Energy, 1980a, p. Intro-1). At the time, international research was coordinated by the

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Global Atmospheric Research Program. Coincidentally, the display window of a bookstore near to the workshop hotel featured *The World According to Garp* (Irving, 1978). One might have imagined that our message was already a bestseller.

The project had five working groups. Four dealt with effects: on the oceans and the cryosphere; on the managed biosphere; on the less managed biosphere; and on economics and geopolitics. The fifth group, which I joined, considered social and institutional responses to the threat. Figure 1 has an excerpt from our report. Except for the first sentence, it could be written today. The path forward seemed so clear that, soon afterward, I wrote what might be the first article proposing a behavioral research agenda (Fischhoff, 1981). I asked Lita Furby, a developmental psychologist with cross-cultural expertise, to help write the workshop paper on 'psychological dimensions of climate change' (Fischhoff & Furby, 1983). Box 1 presents the five projects that we proposed. These, too, seem relevant today.

The path looked bright for research that would be good for science, as well as for society. The projects in Figure 1 and Box 1 all require collaboration among sciences, which could learn from one another, and with publics, who could pose fresh problems and perspectives. However, that was not to be, for reasons that can inform future research.

A missed opportunity

The grand plans of the DOE–AAAS initiative ended with the 1980 Presidential election. In the ensuing period, the physical sciences generally managed to protect enough of their climate-related programs to keep going and gradually increase over time. The behavioral sciences, having no programs to begin with, stayed on the sidelines – for the next quarter century. The few projects during that period suggest the contributions that the behavioral sciences might have made, and might make in the future, toward characterizing the human impacts of climate change and engaging the public in mitigation and adaptation.

The preceding period had seen active behavioral research on energy conservation, prompted by 1970s oil crises. However, that research was being wound down, without having created a sustained institutional presence that might pivot to climate change (Stern & Elliot, 1984). The National Academy of Sciences created a Committee on Human Dimensions of Global Change (HDGC), hoping that someone would fund the research opportunities that it identified (National Research Council, 1992). Willett Kempton and his colleagues showed how a multi-method approach could capture the richness of diverse groups' climate-related decisions (e.g., Kempton, 1991). Ann o Panel IV Social and Institutional Responses. The CO_2 issue appears to be a gradually developing problem that is so far proceeding too slowly to attract significant public notice. Yet it does have aspects that are linked to other high-priority social problems, including the development of alternative energy systems and certain environmental threats. Uncertainties inhibit precise definition of the social costs and benefits of CO_2-induced climate change. Impacts of climate change will not be distributed uniformly; consequently, the economic and social effects for each region would vary greatly. Prevention of CO_2 build-up is a global matter, but individual nations or other political units could act independently to adapt to changing climates. As scientific research on CO_2 progresses, information regarding the risks and benefits of climate change should be diffused through the hierarchy of social units -- ranging from individuals, families, and communities to nations and international groups. Institutions then will be better able to identify and implement appropriate strategies for dealing with the situation. Because of the varied geophysical, biological, and societal effects that may result from CO_2 build-up, the problem calls for an unprecedented interdisciplinary research effort. The format used in this undertaking can perhaps be applied to other complex social problems as well.

Figure 1. Decision-making about climate change: a 1980 call for research and action. Source: US Department of Energy (1980b, pp. vii–viii).

Bostrom and her colleagues studied the mental models that shape the credibility of claims about climate change (e.g., Bostrom *et al.*, 1994). Jon Krosnick and his colleagues pieced together the closest thing we had to a tracking survey of climate beliefs and attitudes (e.g., Krosnick *et al.*, 2000).

As we did little, greenhouse gases continued to accumulate in the atmosphere, where they will take generations to dissipate. Vested interests, opposed to specific climate-related policies (e.g., reduced fossil fuel use, better control of methane emissions), honed their arguments for attacking climate science in general (Oreskes & Conway, 2010). Long-term capital investments (e.g., buildings, transportation infrastructure) were made, constraining future action. Development proceeded as though ecosystems would be as resilient in the future as they had been in the past. Domestic, foreign

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Box 1. Psychological dimensions of climate change: five research projects.

Project 1. Identifying and characterizing subjective aspects of the 'facts' of CO_2-induced climatic change

(1) Where do subjective judgments enter into scientific analyses?

(2) How valid are those judgments?

(3) How well are experts able to identify and assess such judgments?

(4) How can we make better use of experts by better understanding the limits to their abilities?

Project 2. Understanding and improving lay decision-makers' perceptions of the facts of CO_2-induced climatic change

(1) How do lay decision-makers interpret the facts presented to them by experts?

(2) Is this testimony about climate consistent with their direct sensory experience with weather; if not, how are conflicts resolved?

(3) What kinds of information pose particular conceptual problems?

(4) How can such problems be remedied so that decision-makers can make the best use of available scientific knowledge and the wisdom of their own experience?

Project 3. Clarifying and enriching the space of possible action options

(1) What options naturally occur to people?

(2) How is feasibility judged?

(3) What consequences (or side effects) tend to be overlooked?

(4) In what ways are decision-makers prisoners of their own experience?

Project 4. Understanding how alternative responses to climatic change are evaluated

(1) How do people combine multiple and conflicting risks and benefits of various options into a single decision?

(2) How can people's opinions on these issues be accurately elicited so as to inform government officials?

(3) How can faulty elicitation methods distort the values expressed through them?

Project 5. Anticipating and clarifying conflicts created by the inequitable effects of CO_2-induced climate change; offering paths of resolution

(1) How will climate change pit nation against nation, group against group?

(2) What commons dilemmas will be created (or exist already)?

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(3) What sorts of mistrust and misunderstanding will emerge and can be avoided?
(4) Can frameworks or options be devised for conflict resolution?
Source: Fischhoff and Furby (1983).

and national security policies ignored the potentially destabilizing effects of climate change.

In retrospect, the climate science community appears to have played a strong hand poorly, even considering the power of the opposition. By some accounts, over that period, the chance to halt catastrophic climate change was lost (Rich, 2019; Wallace-Wells, 2019). Perhaps things would have been different with a sustained investment in behavioral science research to help characterize human impacts, assess the realism of possible policies, establish two-way communications with the public and guide climate science in relevant directions.

The next section discusses the climate science community's role in missing these opportunities as it framed the issues and controlled research resources. The following section discusses our own role, asking how the behavioral sciences might have been part of the problem. The section after that considers what has – and has not – changed in the recent welcome surge in behavioral science related to climate change and where future opportunities lie. It leads to a discussion of the institutional arrangements needed to realize them. The conclusion asks how different our climate present might have been had the behavioral sciences been fuller partners and what lessons the experience holds for its role in other arenas (e.g., geoengineering, machine learning). Throughout, 'behavioral science' refers to the study of individuals situated in the groups, organizations, cultures and political entities that shape and are shaped by them. 'Climate science' refers to the physical sciences that dominate the field (e.g., atmospheric chemistry and modeling). The biological sciences' experience has been somewhat like our own.[1]

Absorbing behavioral science in climate science

Behavioral science's reception in climate science followed the natural pattern when one discipline owns a problem by virtue of getting there first. That

1 An anonymous review commented, "Back in the early days of social science engagement with climate science, I sometimes quipped: 'It took climatologists more than a decade to discover that there was life on the planet they were modeling; they still haven't acknowledged the presence of intelligent life.'"

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discipline sets priorities and directs resources to studying them. In this case, that discipline was the physical science that first postulated greenhouse gas processes and then painstakingly described their extent, drivers and complications. It pursued the curiosity-driven problem-solving that guides any normal science, with little perceived need or capacity for input from other sciences. It also assumed that the facts would speak for themselves, once they were known with sufficient confidence to be shared.

The specific expression of this general pattern reflected the distinctive features of the lead discipline. Physical scientists excel at analyzing complex, bounded, quantitatively defined problems. The complexity of those analyses means that endless refinements are possible, each needing attention before other disciplines are engaged. With climate, the bounds of the analyses included no behavioral variables, except in highly aggregate form (e.g., energy consumption). Their quantitative formulation excluded behavioral research, unless it could be translated into analysis-friendly terms.

As an added barrier, many physical scientists doubted that behavior could be studied scientifically or that the behavioral sciences are sciences at all. Even sympathetic physical scientists lacked the expertise to identify, recruit and absorb behavioral scientists with complementary knowledge and skills. When funding was available for behavioral science, review panels dominated by physical scientists might find nothing that they liked, because none of the proposed research looked like science to them, with the familiar features of complex, bounded, quantitatively defined problems. When money got tight, behavioral scientists often found themselves last in, first out.

When some climate scientists began to sound the alarm, behavioral scientists might have been useful allies in communicating with the public. Here, too, natural processes left them out. On the one hand, physical scientists wanted to be sure about any specific research results before saying anything. On the other hand, the general reality of climate change seemed so clear that the public would immediately grasp its portent. Scientists who spoke to the public risked professional censure, as seen in some scientists' distaste for Carl Sagan's success. Climate scientists also risked misreading their audience, falling prey to the human tendency to exaggerate how well one understands and is understood by others (Nickerson, 1999). The very intellectual skills that make climate scientists so good at their analyses also make them very different from the general public. As a result, they may have particular difficulty intuiting others' perceptions.

In retrospect, communications from that era overcomplicated the problem and oversimplified the solution. The essence of the problem is captured in "The probable outcome is beyond human experience." Grasping the fateful gamble being taken with our collective future did not require deep

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understanding of any single science's piece of the complex underlying processes. However, directing that concern toward specific possible solutions did require detailed analysis of their costs and benefits. The absence of those analyses exposed climate activists to the claim that "one of the real tragedies that totally distorted the debate over climate change was that it got tied into the solution in a way that if you accepted the first you had to accept the second" (Gingrich, 2017). Whether that framing justified attacking climate science in general, in order to undermine specific unwanted solutions, is a separate question.

Adapting behavioral science to climate science

These barriers to entry notwithstanding, it is only fair to ask how well we exploited what opportunities there were. After all, behavioral scientists were invited to the DOE–AAAS initiative, thanks to far-sighted organizers such as Elise Boulding, Lester Lave, Roger Revelle and Steve Schneider. Did natural tendencies of our own disciplines keep us from doing more? Given that physical sciences were, deservedly, the lead disciplines, could we have done more to connect our research with theirs?

In principle, there were (and are) three possible ways to connect. One is translating our results into the quantitative estimates that their analyses need. The second is helping to make their research more relevant to climate-related decisions. The third is treating the analytical process as a behavioral enterprise, potentially subject to imperfection and improvement. At that time, the worlds of climate scientists and behavioral scientists were too far apart to make those connections without greater effort than we (or they) could (or would) make.

The first kind of connection – translating behavioral results into analytical terms – might have been good for our science, as well as theirs. It would have situated our general theories in specific settings; created clear, shared definitions of variables; promoted practical as well as statistical significance; and produced assessments of uncertainty in terms suited to sensitivity analyses. However, climate analyses had no places for behavioral science knowledge, and we failed to create them. Had we tried, we might have found climate scientists to be reluctant partners. However, running that experiment would have required deeper engagement with climate science and scientists than we could muster. It might also have met resistance from within our disciplines, given the time that it would have diverted from conventional research activities.

Behavioral scientists had more success with the second kind of connection: making climate science more relevant to climate decisions (e.g., Kempton, 1991; Bostrom *et al.*, 1994). The resulting research was, arguably, productive

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scientifically. It revealed how seemingly similar terms can evoke divergent associations (e.g., climate change, global warming, risk), how mental models of physical processes can affect the credibility of scientific claims (e.g., how global warming might produce severe winter storms) and how people can construct preferences for the novel tradeoffs posed by climate-related policies. Progress was easier here because we could do the research on our own and because some climate scientists liked having their story told, even if they did not think that they needed help telling it. We made little progress, though, in helping climate scientists to make their analyses more relevant to specific climate-related decisions, defined precisely enough that institutions and individuals could deliberate them.

We had similarly little success in creating the collaborations needed to make the third potential connection: treating climate science as a behavioral endeavor. All sciences have two subjective elements: professional judgments, which take over when the data run out or need interpretation; and value judgments, which determine which issues are studied, how terms are defined, and how cautiously results are interpreted (Fischhoff & Kadvany, 2011; Fischhoff, 2015). Behavioral science can address both forms of subjectivity in ways that could help climate science to direct and defend its work. However, scientists never like being told that their work is fallible, incomprehensible and incomplete. In order to make our case, intellectually and interpersonally, we would have had to become much more integral to the climate science community. Both we and they bear responsibility for that failure.

What has changed? What comes next?

That long, lean period seems far removed from the recent profusion of behavioral science research on climate change, as seen in this special issue (Sovacool, 2014). The efforts of the dogged individuals who fanned the embers and made that research possible deserve a systematic account. What follows is my assessment of what has changed, what has not and where the opportunities lie for strengthening the three kinds of connection. The next section considers the institutional changes needed to realize them.

Integrating behavioral science in climate models

The behavioral sciences have, as yet, made limited contact with the models that are climate science's core activity. In part, that failure reflects the impenetrability of the models and the forums where their details are debated, except for scientists deeply steeped in them. In part, it reflects the models' focus on variables with planetary effects. As a result, individual behavior appears only in

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aggregate form (e.g., energy consumption, land use), treating the behavioral processes that shape those estimates as a black box.

Behavioral scientists might close this gap in several ways. One is by producing estimates of variables already in the models. A second is by showing how behavioral variables fit into climate models, refining existing relationships or adding missing ones. A third is by evaluating the behavioral realism of the stylized scenarios that modelers use to depict climate futures (Keepin, 1984; Thompson, 1984). A fourth is by doing the integration themselves, aggregating individual behaviors to planetary-scale variables (e.g., Dietz & Rosa, 1997). Each of these activities would stretch our science and require immersion in the world of climate models.

Making climate science more relevant to climate decisions

Making any science useful requires two-way communications with those who depend on it. People need to know what scientists have learned. Scientists need to know what decisions people face. In the climate arena, behavioral scientists have had some success in making the former connection, but little in the latter. For the former, there is a great, and growing, body of theoretically informed, empirically tested knowledge on communicating about climate change, its effects and the response options – as seen in other articles in this issue. That research has found its way to the mass media, advocacy organizations, school curricula and informal science education.

Behavioral scientists have, however, achieved little in communicating decision-makers' needs to climate scientists. Awareness of those needs can be seen in attempts to downscale climate science predictions, as in the regional and sectoral impact analyses of the Third and Fourth US National Climate Assessments (US Global Change Research Program, 2014, 2018). However, those efforts are largely guided by experts' intuitions about decision-makers' needs. Behavioral scientists could inform those intuitions by summarizing and interpreting public concerns. The perceived value of listening to the public may, ironically, be undermined by research emphasizing how much it needs to know.

Treating climate science as a behavioral endeavor

Decision-makers need to know how much random and systematic error there is in the science reported to them. Random error reflects cumulative uncertainty from the data and theories in the analyses (Manski, 2013). Systematic error reflects biases arising from practices such as making conservative estimates, excluding questionable data and ignoring issues that fall outside analytical bounds. Behavioral science on these issues has found its way into climate science through expert elicitation, which uses behavioral methods to extract experts' beliefs and assess their validity (Morgan, 2017). Future research might extend those methods to characterizing sources of uncertainty and the trustworthiness of the research process (Fischhoff & Davis, 2014; Spiegelhalter, 2017; van der Bles *et al.*, 2019).

Decision-makers also need analyses that reflect their values on issues such as how distributional effects are treated; whether future lives and environmental effects are discounted along with future monetary ones; and whether estimates are 'conservative' (and what exactly that means). These are familiar topics in other domains, but they are only beginning to penetrate climate science (e.g., Thomas *et al.*, 2018). In order to represent public concerns, behavioral scientists would have to be at the table when analyses are formulated. Such invitations require trusted personal relations arising from joint service on consensus panels, review committees, interdisciplinary conferences and the like. If we could create those relationships, we might help climate scientists to perform and report the research that is most relevant to the public that needs and supports them.

Over the past 15 years, behavioral scientists have made important contributions to raising awareness of climate science and its predictions. They have also been enlisted in promoting and implementing policies deemed to mitigate climate changes (e.g., energy conservation, renewables, carbon offsets) or adapt to them (e.g., land-use planning, disaster response). Their greatest future contributions may lie in further shaping policies. The next section discusses the institutional supports needed to make that happen.

What will make it happen?

Figure 1 and Box 1 summarize a report calling for behavioral research that would make these three kinds of connection. That report recognized that achieving such "an unprecedented interdisciplinary research effort" (Figure 1) would require extraordinary institutional support. There are historical examples of behavioral sciences coming together to address major societal challenges, such as war, immigration and economic distress (e.g., Lazarsfeld, 1949; Bar-Gal, 1998; Reynolds & Tansey, 2003). There is also systematic study of boundary organizations intended to coordinate such activities (e.g., O'Mahony & Bechky, 2008). Based on my reading of these sources, and my personal experience, behavioral science can play a central role in climate science and policy if it can connect itself to the dominant climate science in these three ways. Doing so will require sustained investments in learning climate science, getting to know climate scientists and becoming part of their activities. These will require changes in relations with the climate sciences and within the behavioral sciences (Hein *et al.*, 2018).

The behavioral sciences are much more welcome today than in much of the past. However, their designated roles are often subservient ones: tell the stories emerging from climate science research; persuade or induce people to take actions deemed climate friendly; or mobilize the public to defend climate science. Although these are essential activities that require the behavioral sciences' core competencies, they do not engage decision-makers in setting the research agenda or identifying policies worth analyzing. Indeed, they may undermine that role by depicting the public as failing to understand climate science (Fischhoff, 2007).

Progress toward such research can be seen in many places (e.g., Pidgeon *et al.*, 2014; Stern *et al.*, 2016; Wong-Parodi *et al.*, 2016; Maibach *et al.*, 2017; van der Linden *et al.*, 2017; Weber, 2017). Some of that research has directly involved climate scientists. In addition to ensuring technical accuracy, such collaborations can also create personal ties that reduce the risk of members of one discipline reading a bit from another and then assuming mastery. Some of that research has included behavioral scientists from multiple disciplines and theoretical perspectives. Such collaborations can not only address the complexity of decisions (and decision-makers), but also reduce the temptation to focus on theories rather than problems. Some of that research has included activists. Such collaborations can not only reduce misunderstanding, but also demonstrate scientists' personal commitment to practical matters.

All of these collaborations take time away from producing conventional peer-reviewable publications. Rather, they result in elaborate interventions whose success or failure is hard to attribute to any of their components. Disciplinary departments have typically told behavioral scientists with an interest in such activities to take it outside, to applied settings or boundary organizations. That strategy might be defended as protecting the basic research that is the lifeblood of applications. However, it also cuts that research off from the reality test of applications and the stimulus that they provide.

An alternative model is to create positions in academic departments that carry the expectation of both publishing in top journals and being useful, or joint appointments in departments committed to each. For faculty holding those positions, time spent with other disciplines and with decision-makers is not wasted. Rather, it is a capital investment in their ability to change the world and learn enough about it to identify phenomena worthy of systematic study. Having such positions might help departments retain idealistic faculty who want, and are willing, to test the practical value of basic research, while still contributing to its creation.

Creating such positions would provide academic departments with a principled defense against charges of ivory tower isolation. Those positions would be not just transient concessions to prove relevance, but central to their mission. Climate change could also provide a reason to change a business model that has created untenable pressures on work–life balance, rewards for careerist resume building, oversold claims and exploitative adjunct faculty positions. Such immersion requires research that is slow, rather than fast-paced and high volume (Medin *et al.*, 2017). A planetary threat needs an academic world worthy of the challenge. It might prompt creating one.

Conclusion

Behavioral science has many dual-process theories with heuristic value for organizing the myriad factors shaping human behavior (Kahneman, 2011). One process involves fast, associative, pattern-matching, affective responses. The second involves slow, deliberative, analytical responses. Although sometimes laden with technical details, climate science communications have long appealed to the former, simpler process. They trust the enormity of the problem to motivate action. The latter process, which more rationally formulates and evaluates alternative actions, was left to others.

For a while, that strategy worked, winning the hearts of many across society (Rich, 2019). However, the analyses needed to translate concern to action were slow in coming, limiting decision-makers' ability to be as rational as they might want to be. Climate scientists naturally wanted to be sure of their results before sharing them. However, their silence left large openings to entities accustomed to making decisions under conditions of uncertainty. Some of those entities saw clear enough threats to their interests that they had no need to wait before acting to forestall climate action. They did not hesitate to communicate forcefully, in science-like language, perhaps relying on behavioral research conducted on their behalf.

Had behavioral science retained its early seat at the climate science table, would that have made a difference? Figure 1 and Box 1 suggest some of the strategies that it would have pursued. These strategies emphasize a decision-making perspective, so that uncertainty need not preclude action; a commitment to the problem, so that disciplinary concerns are secondary; and a commitment to evidence, so that intuitions are no longer an acceptable basis for policies and communications. The ensuing research, like that found in this special issue, has shown that behavior is subject to systematic analysis and not refractory, as it may seem to those baffled by a seemingly inexplicable public. That research, coupled with better organization of our own institutions, might increase the chance of our being consulted on future decisions related to climate (e.g., energy policy, geoengineering) or other great challenges (e.g., gene editing, machine learning), and being ready with useful research when that happens.

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