Does Science Matter?
The Role of Science in Framing Policy Problems

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Assessments of the role of science in the policy process often focus on the use of scientific information in final decision making stages. With that focus, Collingridge and Reeve (1986) conclude that science does not play a central role in policy making. These analyses, however, fail to account for the sometimes significant role that science and individual scientists play in framing policy problems. I provide examples of the role that scientists had in framing current debates about a number of issues, including climate change and disease management, to highlight the power that scientists and science policy decisions have in framing policy problems. In a third example, about scientific inquiry into innate intelligence differences between genders, I argue that scientific inquiry can actually contribute to and create policy problems. The role of science in decision making is often debated, but less frequently considered is the role it plays in framing the very questions for which it is later asked to provide answers. This paper seeks to redress that lack of attention.

Introduction

In their influential book, Collingridge and Reeve (1986) identify two myths about the role of science in decision making. The first is that policy makers begin the decision-making process by collecting all of the relevant information available about the decision at hand in order to reduce the uncertainty. Decision-makers, the authors correctly argue, work in the face of deep uncertainty on a regular basis and do not rely on scientists to reduce uncertainty to a minimal level before taking action. The second myth, related to the first, is that science is capable of generating comprehensive information relevant to a policy dilemma. They argue that policy is not based on scientific 'truths,' as naïve surveys of the relationship between science and policy assume, but rather decision makers collect scientific information to justify their choices that are, in fact, determined primarily by values. The contingent nature of knowledge comes to the surface when science becomes policy relevant because skepticism, which is an integral component of the scientific process, increases whenever there is a high cost associated with potential error. Were decision makers to look to science for comprehensive information about any particular decision, they would not see clear truths upon which to base policy, but rather they would see contention within science at a heightened level because there is a high cost of error associated with policy relevant research. The authors conclude that "Contrary to the myth of the power of science, there is a fundamental and profound mismatch between the needs of policy and the requirements for efficient research within science which forbids science any real influence on decision-making" (p.5).

Collingridge and Reeve's assumptions run counter to the dominant model (often espoused by scientists) of the role of science in society, that is, the assumption that more knowledge will reduce political controversy. The social processes that lead to reduction of scientific uncertainty, however, do nothing to reduce political uncertainty, and when science is used to justify policy decisions the inner workings of the scientific enterprise are exposed to public scrutiny. Under heightened scrutiny, according to Collingridge and Reeve, science cannot not provide clear answers to policy questions. They conclude that, in fact, science does not significantly influence policy decisions.

Collingridge and Reeve correctly refute the myth that policies are made primarily on technical grounds. In only examining the latter stages of the policy process, however, they fail to recognize the sometimes significant role science and its practitioners play in identifying and framing policy problems. Though decision makers may make policy based on other factors and use science to justify their decisions, scientists play an important role in initial framing, a process which circumscribes policy intervention options and defines metrics of success by which subsequent interventions are assessed. Just as technologies and artifacts have politics (Winner 1986, 1978), so too does the research agenda itself. Choices made throughout the process of setting the research agenda, from federal funding decisions to individual investigators' choices of problem areas and research methods, can influence policy problem framing in ways that are not commonly recognized. Drawing from the public policy literature, I discuss the importance of problem framing in policy processes. Then I provide examples drawn from scientific and science studies literatures of situations in which the initial scientific framing has had the effect of limiting policy options to a narrow set of what can be seen in hindsight to be a wider range of opportunities. With time, other framings of these debates have been considered by interest groups, scientists, and others, enabling us in hindsight to identify the importance of the initial framing and speculate about how other research priorities may have led to the identification of different policy problems or their framings. This paper suggests that choices that affect scientific agendas can have far reaching unintended impacts on diverse policy problems.

Problem Framing

Schön and Rein (1994)**,** in their study of persistent policy problems, develop a typology of 'frames' in the policy process, which is useful for assessing scientists' various roles therein. The authors distinguish between rhetorical frames, which are not critical to actual policy formulation, and action frames which inform policy choice and implementation.[1] Rhetorical frames are information and arguments that institutional actors invoke in order to persuade others of the primacy of one policy option over

[1] Some frames can be both rhetorical and action inspiring, making classification difficult. Nevertheless, the framework is useful for theoretical analysis.

another, whereas action frames actually inform the choice and implementation of policy (see p. 32-34). Collingridge and Reeve (1986), by analyzing only the latter stages of the policy process, focus on scientists' role in creating rhetorical frames. Because science is not unitary, it does not provide single simple answers to policy disputes, but rather provides a wide array of sometimes contradictory information from which decision makers select that which suits their needs. This knowledge is then used in rhetorical arguments, but does not, in their opinion, serve as the basis of actual policy making.

Sabatier and Jenkins-Smith (1999) similarly focus only on the role scientists play in creating rhetorical frames when they suggest that research influences the policy process primarily by providing competing advocacy coalitions with information. In their adversarial advocacy coalition model of the policy process, scientists provide groups rhetorical fodder against competing coalitions, as well as the ability to verify or refute competing claims. Actor groups, the authors argue, are rarely convinced to change their 'deep core' positions because most important decisions are based primarily on core values (what Schön and Rein would call 'metacultural framing'). Scientists can influence minor aspects of policy formulations by providing rhetorical arguments for competing coalitions and evaluating competing claims. Sabatier and Jenkins-Smith suggest that due to perceptual filtering, "coalition members will resist information suggesting that their deep core or policy core beliefs may be invalid and/or unattainable, and they will use formal policy analyses to buttress and elaborate those beliefs (or attack their opponents)" (Sabatier and Jenkins-Smith 1999). The assessments put forth by Collingridge and Reeve as well as those espoused by Sabatier and Jenkins-Smith are directed at the role that science plays in shaping policies once the debates have *already* been framed. As such, they relegate scientists to the role of creating ‘rhetorical frames’ that are relatively un-influential in shaping actual policy outcomes and fail to recognize their roles elsewhere in the policy process.

Examples in this paper will show that, in addition to their role in shaping rhetorical frames, scientists (and the factors that influence their problem choice) impact what Schön and Rein call action frames. In their typology, action frames inform policy practices whereas rhetorical frames “serve the rhetorical functions of persuasion, justification, and symbolic display” (1994). Action frames are broken down into three categories: *policy frames*, used by an institution to characterize a specific policy situation; *institutional frames*, which guide policy frames for a variety of policy situations; and *metacultural frames*, which consist of cultural assumptions about the way the world works (Schön and Rein 1994). While some aspects of action framing are likely received wisdom that have little to do with the research agenda (Schwarz and Thompson 1990), the examples given below suggest that individual scientists’ actions as well as policy choices affecting the scientific research agenda, from broad scale funding decisions to factors affecting individual investigators’ selection of problems, can affect the action framing of policy problems in ways that neither Collingridge and Reeve nor Sabatier and Jenkins-Smith recognize.

Science in action- setting the action frame

Climate change

Hart and Victor (1993) explore the history of the climate change research enterprise and the contemporary framing of policy problems surrounding the related policy problems. They argue that scientists are occasionally able to identify policy windows when political, scientific, and policy concerns align to allow them to influence the policy process and institutionalize their funding sources. The current framing of climate change has much to do with that process. Atmospheric and carbon cycle researchers, who comprise the two major streams of research on climate change, had been working primarily independently from one another during the first half of the 20^{th} century. The rise of the environmental movement in the late 1960s and early 1970s, however, allowed policy entrepreneurial scientists to merge the two research streams and secure significant funding for climate change research (Hart and Victor 1993). As argued below, the research agenda that developed from this joining to atmospheric modelers and carbon cycle scientists has had lasting effects on the way policy problems related to climate change are framed.

In their history, Hart and Victor emphasize that the physical scientists, who were largely responsible for shaping the research agenda surrounding climate change, paid very little attention to social science research despite early calculations that human action might alter the atmosphere. Arrhenius had proposed in 1896 that human action might alter the climate through combustion of fossil fuels (Weart 1997), a concern which was lent additional credibility when Hans Suess calculated in 1955 that not all anthropogenic CO_2 was absorbed by the oceans (Hart and Victor 1993). In retrospect, research into the sociological factors that lead to immense emissions of greenhouse gasses can be reasonably seen to be a critical component of the research agenda for climate change. Had the social sciences been integrated into the research agenda, or perhaps played a lead role therein, policy concern about climate change today might be focused more on the social causes of emissions, the factors that make some people more vulnerable to climate change, or on something else entirely.

Hart and Victor emphasize that scientific results did not drive the research agenda that developed around climate change, nor the current framing of the policy problem. Rather, they result from a dynamic in which policy entrepreneurial scientists were able to take advantage of social and political opportunity to make a case for funding of their research. Scientists were able to cast their request for support in a fashion that was politically expedient: politicians wanted to attack problems that could be solved, and key scientists were able to cast climate change as a problem about which additional research would represent significant advances at relatively low cost . In the post-WWII era, physical scientists had credibility they were able to leverage in order to secure support for their branch of science (Kevles 1987; Brooks 1995). Physicists were in positions of power and were able to shape the research agenda relating to climate change and other inherently multi-disciplinary problems. Physicists influenced the framing of policy problems identified during this era merely by advocating for their branch of research.

The current framing of the climate change problem continues to be dominated by atmospheric modelers and physical scientists, and it continues to de-emphasize research on social aspects of the problem. General Circulation Models (GCMs), which embody the current scientific framing, have attained their central status not because of their inherent scientific superiority, but because they allow for a mutual reinforcement of relations between modelers and other groups including policy makers and scientists from other disciplines (Shackley et al. 1998). Rather than considering other types of models which may be of more relevance to local and regional decision makers, modelers continue to focus on global scale circulation models. GCMs are not accurate on local scales, and decision makers around the world who will have to change their behaviors if global emissions are to be reduced are less likely to make decisions based on global averages than on locally relevant information (Morgan et al. 1999).

The Kyoto Protocol represents the dominant contemporary framing of the policy problems relating to climate change, and the primary intellectual source for the Kyoto Protocol was the Intergovernmental Panel on Climate Change (IPCC) second assessment report, which was issued in 1995 and which represents the scientific consensus about climate change. The *Synthesis* section and the summaries for policy makers were especially influential in establishing the framing of the problem (Brunner 2001). In the *Synthesis*, the scientists (mostly atmospheric modelers) frame climate change as 'an irreducibly global problem,' a characterization likely related to their disciplinary interest in global problems (cf. Sarewitz 2004). This framing disempowers individuals and local and regional managers. It disincentivizes them from making significant 'no regrets' changes which have been successful at both mitigating emissions and promoting adaptation. Efficiency technologies that reduce emissions and knowledge social changes that reduce vulnerability are already known and are profitable and desirable on their own merits unrelated to climate (Brunner 2001; Hawken, Lovins, and Lovins 1999). Brunner (2001) argues that this framing does not serve the common interest, but it does serve the interests of those that framed the problem, namely atmospheric scientists (who benefit from the incentives the regime creates for additional research and monitoring) and policymakers who participate in the Kyoto process (who retain significant decision making authority regarding climate change at the expense of local and regional actors and individuals). He argues that the public interest would be better served by reframing the debate in a way that would allow for and encourage adoption of ‘no regret’ strategies, management actions which are beneficial whether or not the climate is changing, but that also mitigate emissions and reduce vulnerability to climate change. The current framing of climate change as irreducibly global, he argues, places excessive emphasis on the politically difficult global interventions and discourages obvious local and regional ‘no regrets’ interventions.

The current framing of climate change as a global atmospheric chemistry problem, which has its roots in post-WWII physicists’ interests, circumscribes policy options. It feeds into a framing of many climate-related decisions as trade-offs between environment and the economy (Hoffman and Ventresca 1999) leading to intractable international policy debates. Lost in the mix are inquiry into social-science aspects of the issue and incentives to adopt no-regrets solutions that would both reduce emissions and reduce vulnerability to climate related effects. As Collingridge and Reeve suggest happens in contested situations, skepticism about scientific data is inflated because of the high economic costs associated with the interventions that the current framing of climate change seems to require (e.g., Brunner 1991). Science is unlikely to provide a technical answer to satisfy the current climate change disputes. What Collingridge and Reeve fail to account for when they discount the role of science in policy debates, however, is the significant role that scientists played in framing our current debates about climate change. Reframing the debate may be the first step toward creating a solution.

Geneticization of biology

People have invoked a variety of explanations for the etiology of disease through the ages, ranging from Hippocrates' now discredited theory of imbalance of bodily humors, to Pasteur's germ theory. Our current understanding, thanks to scientific and technological advances, is considerably more sophisticated and scientists now assign different causes to different diseases. Among the various causes of disease scientists currently recognize are bacteria, viruses, prions, environmental exposure to toxins, as well as inherited predisposition (Thagard 1999). Increasingly, genes are implicated despite the fact that relatively few diseases (e.g., Huntington's and cystic fibrosis) are thought to be exclusively genetic in nature (Keller 1991). For example, despite the fact that the dominant explanatory paradigm for cancer etiology is the 'two-strike theory,' which holds that cancer is caused by genetic predisposition *and* environmental factors (Thagard 1999), cancers such as breast cancer are increasingly being framed as genetic diseases.[2] Indeed, Evelyn Fox Keller suggests that the trend has gone beyond that: "disease itself has begun to move from individuals to their DNA. Genes are not only seen as causing disease; increasingly, they are coming to be seen as the very locus of disease" (Keller 1991). Some scientists take it a step further and speculate about the possibility that even the most minute aspects of personality are determined by genes (Wright 1999).

The quest for genetic explanations has roots in elements of history that on first glance seem unrelated to medicine. Evelyn Fox Keller (Keller 1990) describes the

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[2] It is difficult to quantify the relative importance of genes and environment in causing multi-factoral diseases such as breast cancer. While genetics likely play some role in determining breast cancer rates, genes are not the only factors, and perhaps not the dominant ones. Breast cancer rates can vary by up to five-fold between countries, but studies of Japanese migrants to Hawaii show that women "assume the rate in the host country within one or two generations, indicating that environmental factors are of greater importance than genetic factors"(McPherson, Steel, and Dixon 2000).

influence that physics has had on molecular biology, the branch of biology from which modern notions of genetics emerge. Following the Second World War, many physicists were uneasy about the military use of atomic technologies and some of them came to see genetics as a scientific field in which they could participate. The actions of individuals were instrumental in inspiring physicists to participate in biology. Many new recruits cited the physicist Erwin Schrödinger and his book What is Life?, which argued that genes were the answer to the question presented in the title, as being a significant reason for their transition to working on biological problems. Physicists brought with them their intellectual commitments (including a mechanistic world view), their methods, and their assumption that biological mysteries could be solved through reductionist approaches. Physicists helped to institutionalize molecular biology as one of the major subfields in biology and shaped the research agendas of multiple disciplines. Keller argues that the institutionalization of molecular biology was characterized by critical shifts, including defining genes as the essence of life and changing the goal of biology from observation to experimentation and control. Physicists' work in genetics contributed to many breakthroughs, but as Keller tells it, their most important contribution was the "social authority and social authorization" which they, as respected physicists, brought to the field (Keller 1990). Physicists contributed prestige earned in WWII era engineering projects to the field which they the helped to redefine and institutionalize.

Physicists were influential in institutionalizing in molecular biology its reductionist approach, quest for mechanistic causes, and definition of genes as the root of life. These characteristics are still dominant today in molecular biology and related medical fields. Researchers have sought and continue to seek genetic causes for obesity, sexual orientation, intelligence and other conditions that can alternately be seen as part of the diversity of humanity, the results of environment and upbringing, genetically predetermined, a mixture of the above, or due to any number of other causes. Critics of this trend of geneticization of biology counter that genes do not in and of themselves make anything; they are one component of immensely complex organisms living in even more complex environments (Lewontin 1992; Keller 1991).

The redefining of diseases and other traits as genetic has economic appeal, which might begin to explain how it has become so readily accepted. “A simple and dramatic theory that explains everything makes good press, good radio, good TV, and best-selling books” (Lewontin 1992). In that sense, assigning a simple genetic cause to disease makes for an effective rhetorical framing, enabling scientists to secure additional funding for their research. The medical industries clearly have much to gain from advocating a genetic understanding of disease; each discovery of a genetic disease creates an opportunity to patent the test, and each patented test is a monopoly on a product that is easy to sell to the public through further pushing of the genetic model of disease. Entire industries hungry for profit have sprung up based on the premise that genes for human traits can be identified, isolated and treated or altered (Hubbard and Wald 1999). Inertia is important as well; once scientists and others were able to secure funding for the multi-billion dollar Human Genome Project, the momentum that began with the initial redefining of genes as the central unit of life (a step in which scientists were critically important) became significantly codified in federal research policy. An incredible body of knowledge has been created that now can be drawn upon for explanations of life’s phenomena.

As Lewontin says, “Isolating the gene as the ‘master molecule’ is [an] unconscious ideological commitment” (Lewontin 1992). To again use Schön and Rein’s term, geneticization of disease and other traits has become a metacultural action frame; it has reached the status of cultural belief with far reaching policy implications. The framing has been the basis for influential health care and research policies such as the multibillion dollar Human Genome Project (which lent additional support to that framing); was the reason that when initial searches for a genetic cause for alcoholism were fruitless, an additional $25 million was put toward the effort (Holden 1991), cited in (Keller 1991); and it has the potential to influence even education and welfare policies. Attributing characteristics such as intelligence to genes rather than training or other factors changes the framing of the policy problem. The consequences could be quite negative; in the past, beliefs in inherited differences in intellectual abilities were used to justify racism, unequal treatment, and reduction of welfare policies (Lewontin 1992; Gould 1981; Hubbard and Wald 1999). Believing that the roots of personality, health, and other traits can be found in the genes introduces the frightening prospect that prenatal testing could be used to screen out genotypes that supposedly ‘code for’ undesirable personalities. The existence of those technologies creates pressure for expecting parents to screen out children that might have problems according to this genetic model of disease and personality (Lippman 1993).

Physicists clearly had a role in institutionalizing molecular biology and lending it the credibility it still enjoys today, but scientists are not solely responsible for the way we view disease or the way health care problems are framed. Much of the current problem framing has to do with interest groups and other actors that are motivated by the genetic framing of disease. The critical point is that, had scientists pursued different aspects of the disease, different actors may have been motivated and the cultural understanding of biology might have been different. When we examine the role of science in molding contemporary health care policies, we are not likely to see scientific studies leading to clear policy solutions because, as Collingridge and Reeve suggest, science is unable to provide answers of this sort. Most of the important decisions are probably made based on value judgements and political concerns. That limited view, however, fails to acknowledge the significant role that scientists play in framing overarching action narratives such as the genetic view of disease. Regarding diseases like breast cancer, it would be perfectly reasonable for policy makers to focus on environmental causes (which are potentially manageable, whereas the managing the genetic makeup of constituents is not) and consider policies based on an assumption that disease is caused by environmental factors. There is certainly evidence that environment and individual behavior play as large or a larger roles than genetics (McPherson, Steel, and Dixon 2000). The reason that we seek genetic causes for disease and other human traits has much to do with the history of the field of physics, the influence it had on biology, and the prestige that it lent to the reductionist, mechanistic subfield of molecular biology. The genetic framing of disease has significant implications for the problems with which policy makers wrestle and the options they consider as interventions.

Gender Differences in Intelligence

Harvard University president Lawrence Summers sparked significant controversy when, in 2005, he suggested that achievement differences between men and women in technical fields might be due to genetic differences rather than social causes and called for research into some of the causes (Summers 2005). The National Organization for Women and other groups called for him to resign his post following his remarks, suggesting that social pressures are responsible for much of the observed achievement gap and that his statements do nothing to reduce the social inequities they saw as the root cause of the discrepancies. Given opportunities, women have made up some of the observed achievement gap. In 1970, for example, women made up only approximately 5% of the law student and 8% of medical student populations; they now represent about half of the student populations in both fields (Muller et al. 2005). In other fields, however, the gains have not been as significant, suggesting that social prejudice might play a role. Even today in fields where women earn the majority of PhDs, such as psychology, they hold only a small fraction of faculty positions, and the gap is more noticeable in the most prestigious universities (Schiebinger 1999). While it can be argued that his suggestion for additional research is a reasonable one coming from the President of a university, I do not believe that seeking to identify genetic causes for differences in intellectual abilities is a reasonable goal for scientists to undertake.

Western science has a long and unfortunate tradition of seeking evidence to justify societal inequities. Craniometry, the measure of skull size, was used as evidence for men’s intellectual superiority over women and that of some races over others. In reanalyzing skulls used in some of the key studies and recalculating statistics, Gould (1981) has shown that just how important expectations are in determining how research results are interpreted. His expectations were that there were no significant differences in brain cavity size between the sexes and between races, and that is essentially what he found. Researchers who expected to find differences did so, and their research was used to justify sexism and racism.

Disputes about evidence are common and I do not mean to suggest that disputed evidence constitutes a sufficient reason not to pursue a research agenda. As worrisome as the fact that incorrect results may serve to exacerbate societal problems is the concern that inquiry into innate differences in intelligence can be a self-fulfilling prophesy. The way we investigate the world can actually affect the world (Cartwright 1999). Reminiscent of Heisenberg's uncertainty principle, researchers in a recently published study found that women who read an essay claiming that women are worse at math than men due to innate gender differences performed much more poorly on subsequent math tests than did women in two other groups who read essays saying that 1) observed differences in ability are due to societal factors, or 2) that there are no differences in ability (Dar-Nimrod and Heine 2006). If these findings are representative, they suggest that the very act of researching innate differences in abilities between groups may actually create or exacerbate observed differences. The act of studying the world in fact changes it, making Summers' call for additional research a problematic proposal that would only serve to justify sexism.

In this example, science not only frames policy problems, there is a chance that it can exacerbate already existing ones. On one hand, Lawrence Summers' call for a research program into innate differences in gender abilities can be seen as just contributing to the rhetorical framing of sexism in academia. On another, his contribution was an action frame in terms of setting both the scientific agenda (if heeded), but also contributes to a metacultural frame that is self-fulfilling. Merely studying gender-related intelligence differences may exacerbate the problem researchers seek to explain.

Conclusion

Scientists play an important, yet often unrecognized, role in framing policy problems early in the policy process that Collingridge and Reeve do not account for. The examples provided here are quick overviews of incredibly complex histories, and necessarily leave out many social, technical, and political factors that lead to problems being framed the way they ultimately are. The relationship between science and framing of policy problems is far from deterministic. These examples are intended to demonstrate, however, that scientists do play a role in framing policy problems, a role which is often ignored when considering the influence of science on policy.

Science policy decisions, including such things as focusing on math and science to the exclusion of humanities and social sciences in primary and secondary education, will shape the way future problems are considered. Budgetary decisions to fund one field of science over another, or to establish new infrastructure that affects the research agenda can similarly affect policy framing. This argument is not intended to suggest that society should cease our attempts to understand the world around us. Rather, it does lend additional support to the claim that, because science and technology have drastic impacts on our society, the process of setting research priorities should be democratized.

Many of the recalcitrant problems with which modern decision makers wrestle have single dominant policy framings. The examples provided here show that for some problems, if not all, multiple framings are possible. Recognizing the social causes of climate change and the multiple scales in which impacts are likely to be felt and on which adaptation is possible may empower local decision makers to contribute to a solution. Climate change is not an irreducibly global problem but the scientific research agenda reinforces that framing. Similarly, recognizing that there is more to human disease (and indeed behavior) than genes empowers people to make decisions that promote well health. Knowing that multiple framings to contemporary problems are possible and encouraging that diversity through a pluralistic and democratized science agenda may help address some seemingly intractable problems. Diversifying the research agenda and encouraging multiple strains of research into policy problems may help to promote recognition of the multiple possible framings of policy problems.

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