

Social Norms and Global Environmental Challenges: The Complex Interaction of Behaviors, Values, and Policy

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Government policies are needed when people's behaviors fail to deliver the public good. Those policies will be most effective if they can stimulate long-term changes in beliefs and norms, creating and reinforcing the behaviors needed to solidify and extend the public good. It is often the short-term acceptability of potential policies, rather than their longer-term efficacy, that determines their scope and deployment. The policy process should include a consideration of both timescales. The academy, however, has provided insufficient insight on the coevolution of social norms and different policy instruments, thus compromising the ability of decisionmakers to craft effective solutions to the society's most intractable environmental problems. Life scientists could make fundamental contributions to this agenda through targeted research on the emergence of social norms.

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The world's people are confronted with a new class of environmental problems, unprecedented in their complexity and their spatial and temporal reach. These problems involve interconnected ecological and social systems operating on multiple scales and include climate disruption, ozone depletion, persistent organic pollutants, population and species declines and extinctions, emerging diseases, and antibiotic resistance.

Some have argued that progress on these problems can be made only through a concerted effort to change personal and social norms. They contend that we must, through education and persuasion, ensure that certain behaviors (e.g., controlling fertility, reducing material consumption, biking to work, eating locally grown foods) become ingrained as a matter of personal ethics. If enough people or certain people (e.g., those with disproportionate social influence; see Christakis and Fowler 2009) adopt these norms, there may be a tipping point (Levin et al. 1998, Gladwell 2000) such that the proenvironment norms become widely shared and environmentally friendly behaviors become pervasive. Computer simulations show that this tipping point may be as low as 10% of the population,

if the minority is "consistent and inflexible" in its beliefs (Xie et al. 2011).

We agree that social norms are important, but social norms and values shift in complicated and often unexpected ways (Ehrlich and Levin 2005) and respond to myriad forces at both lower and higher levels of social organization (Ostrom et al. 2002). If no tipping point is reached, a minority of the population potentially shoulders the burdens of proenvironment behavior; moreover, their efforts alone are unlikely to have a sufficient impact on the types of emerging environmental challenges that the world faces. Substantial numbers of people will have to alter their existing behaviors to address this new class of global environmental problems. Alternative approaches are needed when education and persuasion alone are insufficient.

Policy instruments such as penalties, regulations, and incentives may therefore be required to achieve significant behavior modification (Carlson 2001, House of Lords 2011). Policies apply to everyone in a particular jurisdiction and, as a result, ensure that the burdens of proenvironment behavior are widely shared, which increases the probability of measurable positive outcomes.

Table 1. Summary of policy instruments, changes in norms, and potential for a boomerang effect.

Policy instrument	Examples	Process of norm change	Potential boomerang effect
Active norms management	Advertising, information, appeals	Directly influencing personal norms, influencing belief about what others are doing	Revealing that others are not doing their part
Changing architecture	Making desired behaviors more convenient or more visible	Cognitive dissonance, increasing social disapproval for failure to engage in easy behaviors, creating targets for social norms (visible behaviors)	Revealing that others are not doing their part
Financial interventions	Taxes, fines, allowances, subsidies	Repeated behavior and experience, signaling the importance society places on certain behaviors	Creating an economic rather than moral calculus, creating more resources for behaviors that undermine intended goal (subsidies)
Regulations	Laws, standards	Signaling the importance society places on certain behaviors, repeated behavior and experience	Creating incentive to regain lost freedoms, revealing that bad behaviors are more pervasive than previously believed, crowding out “other-regarding” behavior

And yet, many policies are expensive, requiring, for example, new infrastructure or enforcement efforts. Policies can become more cost effective in the long run if they feed back to influence social norms, so that behaviors become self-reinforcing even in the absence of external regulations or penalties. We know that values influence behaviors. What policymakers need to exploit is that behaviors can also influence values.

This happens in part because people's identities can be influenced by their own behaviors and those of the people around them (Bem 1967). People can also learn to value something through their experiences. Recycling provides a simple example. In many places, recycling programs began with much grumbling, under the pressure of increased costs for oversized garbage loads. Today, recycling is second nature for many people, who have come to view it as a normative behavior. This has led to increased recycling even under reduced enforcement. Prohibition provides an illuminating counterexample: Short-term declines in the consumption of alcohol in the face of severe penalties did not lead to widespread or long-term temperance. Effective policies, then, are ones that induce both short-term changes in behavior and longer-term changes in social norms.

Some may object to an expanded governmental role in influencing norms, but we feel strongly that our recommendations can be carried out in a way that abides by the principles of representative democracy, including transparency, fairness, and accountability (Norton et al. 1998). Furthermore, government is only one of many parties and interests in democratic systems acting to influence values and social norms; other parties include, for instance, corporations, charitable organizations, neighborhood groups, organized religions, and public and private schools. Therefore, people's behaviors, values, and preferences—and the social norms to which they give rise—are under continuous pressure, but government is uniquely obligated to locate the common good and formulate its policies accordingly. A central role of academics in this process would be to elucidate both the intended and the unintended effects of governmental

policies and regulations on social norms, to help ensure transparency and a focus on the common good.

Scientists have made significant contributions to the literature on collective action, elucidating the conditions under which it can emerge, spread, and persist. Additional contributions are needed to evaluate the ways in which higher-level institutions—such as governments—can alter the environments in which agents make decisions and potentially alter behaviors and social norms. Government policies intended to alter choices and behaviors include active norm management, changing the conditions influencing behaviors, financial interventions, and regulatory measures. Each of these policy instruments potentially influences personal and social norms in different ways and through different mechanisms. Each also carries the danger of backfiring, which is often called a *boomerang effect* in the literature (e.g., Schultz et al. 2007)—eroding compliance and reducing the prevalence of the desired behaviors and the social norms that support those behaviors (see table 1).

In what follows, we first offer some definitions and then review each of the four types of policy instruments, offering examples of both how they work to change behaviors and norms and how they might backfire. We emphasize here that the scientific understanding of these issues is far from complete; there is a woeful lack of information on the policy–behavior–norms nexus. We therefore close with some recommendations—including a research agenda for life scientists, in collaboration with social scientists, which would allow greater contributions to this pressing issue of changing personal behaviors and social norms to resolve the world's environmental problems.

Definitions of terms

We adopt Ellickson's (2001) definition of a *social norm* as “a rule governing an individual's behavior that third parties other than state agents diffusely enforce by means of social sanction” (p. 3) for those who violate the norm and with rewards for those who follow it. We contrast this with *personal norms*, which are rules governed by self-sanctioning

or reward (feelings of guilt or pleasure) and are followed irrespective of what others might think. There is not necessarily a bright line between the two; when people have strongly held beliefs, they often proselytize those beliefs, and socially enforced behaviors may eventually become internalized (Hopper and Nielsen 1991).

Social norms may exist even when there are government regulations constraining behavior. The likelihood that any of us would get caught and fined were we to drop a candy wrapper in a park, for instance, is very small; we probably resist littering not because of the state regulations but because of personal (e.g., “I’m not the kind of person who litters”) or social (e.g., “I wouldn’t want others to think I am the kind of person who litters”) norms.

Various authors further dissect social norms into different categories having to do with, for example, conduct, tasks, and allocation rules (e.g., Therborn 2002). Our intent in this article, however, is not to provide an exhaustive review of social norms (which we have neither the expertise nor the space to do) but to provide an overview for life scientists, from an interdisciplinary team interested in the issues, of the potential links between policy instruments and social norms. One useful distinction for that endeavor is that between descriptive and injunctive norms (Lapinski and Rimal 2005). The term *descriptive norms* refers to beliefs about what is actually being done by others (our belief about how often others engage in certain behaviors, such as drinking alcohol or recycling), whereas the term *injunctive norms* refers to beliefs about what other people think ought to be done. Only injunctive norms seem to carry a direct threat of sanction, but individuals often fear sanctions should they drift too far from the descriptive norm of behavior. As we discuss below, descriptive norms can play an important role in governing people’s behaviors.

It may seem ironic to discuss the role of the state in helping create, strengthen, or sustain social norms when, by definition, social norms operate outside of the realm of state intervention. But just as there is no bright line between personal and social norms, it is difficult to understand social norms absent conditions created by governments and political processes. As Miyashita (2007) wrote, in discussing the emergence of an antimilitaristic norm in post-World War II Japan, “Norms rarely emerge spontaneously: They are often [a] reflection of underlying material interests and [the] resulting political struggles.” State interventions can change social norms (e.g., they can allow for sustained behavior change even if state intervention ceases), just as social norms can influence or constrain what actions the state can consider.

Active norm management

Governments can actively manage (i.e., try to influence) norms through such things as advertising campaigns, information blitzes, or appeals from respected figures. “Give a Hoot, Don’t Pollute” television ads, distribution of information on the hazards of secondhand smoke, or President

Carter exhorting the nation’s residents to turn down the thermostat in the midst of an energy crisis are all examples. This type of social norms management is often seen as less coercive and less expensive than other regulatory measures (Ela 2009).

The appeals potentially work on two fronts. The first is to get individuals to revisit and rethink their personal norms. Should they be more environmentally conscientious, healthier, more patriotic? The second (and probably more powerful) is to indicate to recipients that this is an important issue that many people care about. People may engage in certain behaviors not because of personal norms but because they desire the esteem or acceptance of others (McAdams 1997), want to signal their willingness to cooperate (Posner 2000), or look to the behavior of others to determine their own behavior, particularly in situations of ambiguity (Lapinski and Rimal 2005). An emphasis on social importance may also cause people to update their estimates of the likelihood of sanctions for certain activities (e.g., littering, profligate energy use) and reduce deleterious behaviors accordingly (Green 2006).

The probability of a boomerang effect from such appeals is low (except in the most avidly antiauthoritarian subpopulations), but in many cases, they have limited effectiveness. Household visits immediately following President Carter’s speech, for instance, showed that only 27% of households had their thermostats set below 65 degrees Fahrenheit, and there was little difference between the households that had and those that had not heard the appeal (Luyben 1982). Campaigns directed against binge drinking on college campuses often have little effect (Clapp et al. 2003). Similarly, public campaigns to increase rates of recycling tend to have strong responses only when a neighbor or block leader makes a face-to-face visit to households (Burn 1991)—an expensive and time-consuming approach in large populations. However, government information about the dangers of secondhand smoke has had a significant impact on smoking behavior through increased social sanctions against public smoking (Lessig 1995).

Another form of social norms management involves providing information to individuals or households about the prevailing norms of behavior—a descriptive norm. Therefore, college campuses provide information on actual frequencies of binge drinking (which are generally lower than most students believe them to be); public utilities include bill inserts showing how a household’s energy use compares with that of the local neighborhood. The rationale for these appeals is that people want to conform, that they use information about peer behaviors as a yardstick against which to measure their own behaviors (Schultz et al. 2007).

This simple provision of information has been shown to be effective in many cases. For instance, cards including information about how many other guests in a hotel room had reused their towels increased towel reuse significantly when compared with cards containing only a proenvironmental message (Cialdini 2005). Similarly, in a field test of

energy consumption, Schultz and colleagues (2007) showed that the descriptive norm, when paired with an injunctive norm (a smiling face for lower-than-average energy use and a frowning face for higher-than-average energy use) did significantly decrease energy use in a San Marcos, California, community. (See figure 1 for some further examples.)

The descriptive norm approach can, however, induce a boomerang effect. Those who are doing better than average (drinking less, using less energy) may alter their behaviors toward the average—either to conform or because they feel that it is unfair that others are not doing their part (Blamey 1998). Indeed, in the San Marcos field trial described above, those households using less energy than the average actually increased their energy use by over 8% when presented only with the descriptive and not the injunctive message.

Descriptive norms and direct normative appeals can alter behavior, but they seem to work best in situations in which behaviors directly and publicly harm others (e.g., public smoking) or in which there is relative ease of conformity (e.g., towel reuse) potentially coupled with a face-to-face appeal for a neighborhood ethic.

Changing the conditions influencing behaviors

Governments can alter people's behaviors by changing the conditions (often called *choice architecture*) influencing those behaviors. This approach was highlighted by Thaler and Sunstein (2008), who asserted that governments need not restrict people's freedom of choice through regulation but could, rather, alter the architecture of decisionmaking (e.g., product placement, opt-in and opt-out schemes) to move people in great numbers toward better (healthier, more prosocial) behaviors. Two primary approaches to altering choice architecture that could have a significant impact on social norms include making behaviors more convenient and making them more visible.

Recycling provides an example of the former. Relative to all other interventions for increasing recycling rates—increased fees for garbage pick-up, local regulations about solid waste volumes, bottle deposits, information campaigns—making recycling more convenient has had the single biggest impact on recycling rates. Households with commingled curbside recycling had higher recycling rates than did households with separated curbside recycling, which, in turn, had higher rates than did households with access only to a drop-off site (Carlson 2001). Moreover, when recycling is made convenient, there is little difference in recycling rates between proenvironment and environment-neutral households.

Making behaviors convenient may strengthen both personal and social norms. The first may occur through a phenomenon that psychologists call *cognitive dissonance*. In short, people desire congruence between their beliefs and actions. In a classic experiment, Festinger and Carlsmith (1959) had subjects perform a very boring task (e.g., repeatedly turning pegs a quarter turn for an hour). Some subjects were then asked to do the experimenters a favor by telling

the next subject (actually an actor) how compelling the task was. Some students were paid \$20 to do this (the equivalent of about \$150 today), others were paid \$1, and a control group was not asked to perform the favor at all. When asked to rate the task at the conclusion of the study (not in the presence of the actor), those paid \$1 as persuaders rated the task significantly more positively than did the \$20 or control group. Festinger and Carlsmith (1959) concluded that the \$1 group had been forced to internalize the belief about interest because they otherwise had no compelling reason to mislead the actor (\$1 was not enough justification for lying). The students in the \$20 group had no such need for internalization, because they felt that they had sufficient motivation for misleading the next subject. Similar experiments have subsequently reinforced the existence of this phenomenon (but see Bem [1967] for a critique of cognitive dissonance theory). To return to the recycling example, making it convenient may actually cause participants to internalize the norm required to sustain that behavior; because they are not being compelled to recycle through regulation or cost, they may come to believe (through cognitive dissonance) that they are doing it because they value that behavior.

Woersdorfer (2010), in examining the emergence of cleanliness as a social norm, notes the potential for social norms to become internalized as personal norms: Behaviors originally practiced for the social reward may become rewarding in themselves, because consumers associate the resulting positive feelings with the behavior itself rather than with the approval of others. At the same time, increasing the convenience of a behavior can increase the social sanctions for failure to participate in that behavior. In the case of recycling, for instance, recyclers understand a failure by others to participate when recycling is inconvenient but feel greater opprobrium toward noncompliers when recycling is very convenient (Carlson 2001).

Governments can also change the architecture governing behaviors by making them more visible. A fundamental requirement for an effective social norm is that people are able to ascertain (either directly or through inference) when the norm is being violated (Ela 2009). Not all activities lend themselves to this visibility, and in some cases, making behaviors more visible may violate privacy standards, but there will be some targets of opportunity here. This could include, for example, requiring public buildings to have displays of resource use, making energy meters in apartment complexes more visible, or simply using stickers (e.g., “I voted today”). It remains to be seen how publicizing previously (more) private behaviors by the Facebook and Twitter generations might alter the types of behaviors amenable to molding by social norms.

The largest potential boomerang effect from these approaches is similar to one already identified above—that those people who are doing better than average may discover that others are not doing their part and may reduce their efforts accordingly. Nonetheless, these relatively nonintrusive measures, although they are not directly targeted at norms,



can effectively change both personal and social norms and can increase the prevalence of desirable behaviors.

Financial interventions

Governments can use a range of approaches to alter the economic calculus associated with behaviors. These approaches include discouraging some consumptive behaviors by increasing the price of certain commodities to reflect the opportunity cost to society. So, for instance, a carbon tax could be levied on gasoline consumption, with the value of the tax being chosen to reflect the costs to society of, as an example, air pollution and climate change; cap-and-trade approaches can be used to establish a protective limit (i.e., the cap) for pollution and to establish market mechanisms (the trade) to ensure efficiency in adhering to the limit. Governments can also discourage certain undesirable behaviors by levying a fine and can encourage desirable behaviors through subsidies.

Economists often recommend financial interventions as a way of aligning private costs and benefits with social costs and benefits. These interventions can be highly effective in changing behaviors, particularly when the price increase is significant relative to household income. Price increases, however, are often politically infeasible, and there may be alternative mechanisms for achieving similar outcomes at a lower cost. Price increases can serve to influence or reinforce personal norms by altering consumer experiences. For instance, Thøgersen (2002) found that the propensity for consumers to engage in prosocial behavior by buying organic wine depended on whether they had previously purchased organic wine, even after correcting for personal norms regarding organic products. In other words, personal experience activated a norm and increased the future frequency of that behavior. Consumers directed to new consumption patterns under price increases may experience a similar behavior-induced norm activation. Permanent diversion away from undesirable consumptive activities could occur if people have found or created more desirable substitutes, even if price increases lapse. This approach can, however, backfire in the case of “snob goods”—those goods that people consume precisely because they signal the wealth of the consumer. Therefore, increasing the price of such things as fur coats or Hummers may actually increase the desire to have these items among certain segments of the population (Kübler 2001).

Fines can also be an effective way to alter behavior, in part because they (like social norm management) signal the seriousness with which society treats the issue. Effectiveness, however, generally relies on low enforcement costs. In some cases, imposing financial penalties can actually increase the undesirable behaviors, because what had been controlled by personal or social norms now becomes a primarily economic concern. Perhaps the most widely cited example of this phenomenon was the imposition of a fine for parents who were late in picking up their children from daycare centers in Haifa, Israel (Gneezy and Rustichini 2000). The imposition of the fine substantially increased parental tardiness. This occurred because the previous normative constraints on poor behavior (“It is not right for me to force the daycare attendants to work overtime for no pay”) were annulled by a financial contract (“I am paying them to stay late”). Frey (1993) made the same point with respect to licenses for pollution—once they have been paid for, the payer has secured the right to pollute, with no moral sanction attached to the activity.

An alternative or complement to the fine is the subsidy. Governments have used subsidies for such things as promoting charitable contributions, installing energy-efficient appliances, and biking or carpooling to work. Paying people to engage in socially beneficial behaviors can have a positive impact, although subsidy schemes have to be carefully designed to ensure their effectiveness and fairness (Macintosh and Wilkinson 2011). Subsidies can backfire if they increase the resources that people can devote to behaviors that undermine the intended goal. A consortium of over 200 partners in the United Kingdom, for instance, has supported the Change4Life campaign, encouraging residents from across the nation to swap unhealthy habits for healthy ones. In one component of the program called *The Great Swapathon*, participants receive a £50 book of vouchers good for healthier foods and activities. There is evidence, however, that some participants have used the savings to increase their consumption of unhealthy products (House of Lords 2011).

Financial instruments can be effective ways of altering behaviors and may even reinforce personal norms through the effects of repeated experience, but their imposition should be sensitive to their capacity to undermine existing norms. They work best when the sums involved are significant relative to household income, when the policy signals

Figure 1. Public messages seeking to alter behaviors by invoking a social norm. (a) A poster designed by Ivan Trushin as part of a University of Wisconsin (UW)–Stout social-norming campaign. UW–Stout has launched several of these campaigns through the university housing department using student designers in the Housing Design Office. (b) A poster in use at Arizona State University to encourage those who are ill to stay home. No direct reference is made to what others are doing, but the image conveys the notion that “standing out” from the crowd causes unhappiness. (c) A logo on every residential recycling bin in Tempe, Arizona, reinforcing the perception that recycling is a community activity that enjoys widespread participation (“[all of] Tempe recycles”). Photograph: Ann P. Kinzig. (d) A poster used by the US National Institutes of Health to curtail adolescent drinking. Note the reference to what “most” kids are doing (<http://pubs.niaaa.nih.gov/publications/poster.htm>).

the importance of particular prosocial behaviors, and when the instrument has low enforcement costs.

Regulatory measures

Governments can introduce a variety of regulatory measures designed to restrict (e.g., no smoking in public places) or eliminate (e.g., ban on dumping of toxic waste) individual choices. Regulations are often changes in the assignment of property rights and need not always place the cost on the entity generating the harm, because an alternative solution may promote the highest social value at a lower cost. Rather than tax a polluter, for instance, it may be cheaper for people affected by pollution to shield themselves from the harm (Coase 1960). Regulations are often supported by other types of government interventions (e.g., fines for noncompliance) or are directed toward organizations or agencies to activate one of the other interventions (e.g., government regulations requiring utilities to include data on average use in bills).

Laws and regulations, like fines, can serve to create or reinforce social norms merely by signaling to the members of a community that this is an issue that others think is important. Some have argued that regulations are inherently coercive and cannot or should not exceed implied levels of public permission for such regulations. An alternative viewpoint is that governments can and even should move beyond extant levels of public permission in order to shift norms, allowing public sentiment to later catch up with the regulation (House of Lords 2011). The abolition of slavery in the United States (Guelzo 2004) and the ban on smoking in public places in the United Kingdom are both government actions that exceeded public sentiment at the time but later gained widespread public acceptance.

Brehm (1966) identified conditions under which people will be motivationally aroused to regain lost behavioral freedoms. If government regulations induce this arousal, they may backfire. The introduction of a new regulation may also signal to people that “bad” behaviors were more pervasive than they had previously thought, giving them a descriptive norm against which to judge their own behavior. So, for instance, a government push against tax evaders may lead people to believe tax evasion itself is widespread or rampant so that they increase their own propensity to evade taxes (Chang and Lai 2004), either because they have discovered a social norm (held by others) for tax evasion or because they become resentful that others are not doing their part. Similarly, a study of the use of regulations to increase environmental quality in rural Colombia (Cardenas et al. 2000) showed that regulation actually caused conditions to deteriorate. Cardenas and colleagues (2000) concluded that people tend to strike a balance between self- and group interest when making decisions but more highly weight self-interest in the presence of regulation, since it is assumed that the regulation secures the group interest.

Each of the government interventions can influence both personal and social norms, although they do so through

different mechanisms. Only social norm management directly targets norms. Choice architecture, financial instruments, and regulations can all alter social norms by causing people to first change their behaviors and then shift their beliefs to conform to those behaviors. It must be remembered that policies will not always change personal or social norms—as is evidenced by the Prohibition example at the beginning of this article—nor would we want them to. If people hold deep-seated beliefs, values, or preferences that conflict with the stated policy goals, they are unlikely to internalize these goals as personal norms or to participate enthusiastically in enforcing them as social norms. In other words, government policies are not being visited on a blank slate of citizen values and preferences. Considering the impact of preexisting norms and behaviors on the likely outcomes of government policies designed to alter behaviors and norms is essential. There is, however, an alarming lack of information about how particular policies might intersect with behaviors and norms to create sustained outcomes (House of Lords 2011).

When it comes to environmental issues, two different types of social norms are at play in these dynamics—social norms of conformity or cooperation and proenvironment social norms. Only the first type need be present to induce proenvironment behaviors (although proenvironment personal norms may emerge from this through, e.g., cognitive dissonance, experience, or associating the positive feeling from social approval for an act with the act itself). This distinction is important; norms of conformity and cooperation are far more universal than are proenvironment norms and are therefore far more powerful in inducing proenvironment behaviors that do not conflict with preexisting values or preferences. In other words, proenvironment values are not a necessary prerequisite to proenvironment behaviors.

A research agenda for life scientists

Life scientists have made several seminal theoretical contributions on the conditions under which cooperation might emerge in social groups faced with a collective action problem. (By *collective action problem*, we mean a situation in which sufficient cooperation can benefit everyone, but there is some incentive to cheat or to seek a free ride. Many environmental problems that require changes in individual behavior are collective action problems.) Axelrod and Hamilton (1981) showed convincingly that the emergence of cooperation in a group playing a repeated Prisoner's Dilemma game required some sort of sanction against noncooperators—a “tit for tat” approach. Nowak and his colleagues (Nowak and May 1992, Nowak et al. 1994) introduced structure to the group, with individuals preferentially interacting with their neighbors, and showed that this could fundamentally alter the outcome (see also Durrett and Levin 1994). Hirshleifer and Coll (1988) examined the role of mistakes in executing strategies. Other scientists have investigated the role that *strong reciprocity*—rewarding cooperators and punishing noncooperators—has on the emergence

and maintenance of cooperation (e.g., Gintis 2000, Bowles and Gintis 2004) and how network structure influences outcomes (e.g., Zhong et al. 2006, Chen et al. 2007). Using a combination of field and experimental tests, Janssen and colleagues (2010) found that a combination of punishment and communication was most effective in solving social dilemmas. The general insights are that cooperative behaviors are more likely to emerge with repeated interactions in smaller, more homogeneous communities (or in networks that can recreate these conditions) that use punishment and communication to enforce norms and where there are few mistakes in propagating strategies or judging the need for sanctions.

Social scientists have made seminal contributions as well; many of the empirical studies cited in this article originate in law, psychology, economics, behavioral economics, anthropology, political science, and sociology. We know, for example, that the effective management of any commons requires sensitivity to local conditions, sound monitoring, graduated sanctions, and conflict-resolution mechanisms (Ostrom 1990). From an analysis of existing environmental treaties, we have learned that successful cooperation depends on such things as the number of countries involved, their heterogeneity, their trade relations, and their technical interconnections (Barrett 2003, Sandler 2004).

Significantly extending our understanding of environmental policy, behavioral change, and norm emergence will require contributions from several disciplines and collaborations across disciplines. Life scientists have a role to play in this by extending their existing theoretical analyses. To be effective, scholars of all stripes will have to extend their capacity to collaborate with decision- and policymakers in order to ensure realism and relevance. We next list five areas in which we believe life scientists could contribute through their scholarship and return in the last section to the issue of collaboration between scientists and decision- and policymakers.

1. More realistic policy interventions in collective-action models. Scientists should introduce perturbations in their models of cooperative emergence that mimic the policy interventions described above. These could include an abrupt change in the payoff structure (making some behaviors less costly by changing choice architecture or more expensive by imposing fines), a change in the viscosity of strategy switching due to the existence of norms, or the elimination of (potentially dominant) behaviors through regulations. These abrupt changes could be augmented with slower timescale changes that represent reinforcement or erosion of desired social norms, consistent with the literature review above. Scientists could also effectively examine how combinations of different policy interventions and of the relative timing of deployment play out.

2. The role of error (deception) in displaying and detecting behaviors. Social norms rely on the capacity of individuals

to judge and potentially sanction the behaviors of others. These sanctions introduce a motive for deception—tricking others into believing a certain behavior is being followed even when it is not. One may water a lawn in the dead of night, for example, or roll an empty recycling bin to the curb. (More sobering examples include the drastically different public and private behaviors of most child abusers.) Scientists could effectively explore the impact of certain agents engaging in deceptive behaviors; the incentive to do so will rise with the sanctions and will decline for more visible behaviors.

At the same time, we are not always effective judges of the behavior of others. People tend, for example, to assume that other members of their social group are behaving the way they do (Bicchieri 2006), which may cause errors in agent judgments about descriptive norms. Conversely, people may ascribe a greater prevalence of negative behaviors to members of a group very different from their own social group. Both deception and errors in judgment will influence the capacity for social norms to emerge and persist.

3. More realistic network structures. Examinations of the emergence of cooperation tend to be focused on single network structures—for example, the nearest neighbor, a small world, fully connected. In reality, most of us are simultaneously embedded in many networks, and each may have a distinct structure. Social norms are not just enforced in spatially localized neighborhoods but through more distant geographic connections sustained through social media networks, exchanges of letters and e-mail, and periodic face-to-face visits. Many of us value the approbation of more geographically distant friends and colleagues over that of our neighbors, but policy interventions are often targeted at particular geographies. This has important implications for the emergence of social norms that need to be explored.

4. The role of absolute versus relative payoffs. Many game-theoretic treatments of strategic behaviors—from individual voter models to multinational treaty negotiations—assume that an agent will adopt a strategy that has the highest absolute payoff. This contradicts the way many people and even nations behave. Consider, for instance, the well known “ultimatum game” between two participants. Participant 1 is given some money (say \$10) and told to make an offer to participant 2. If participant 2 rejects the offer, neither party gets anything. If participant 2 is responding only to absolute payoffs, he or she should accept an offer of \$0.01 (which is still better than nothing, in absolute terms). In reality, in many cultures, participants make relatively fair offers and reject any offer below about 20% (Oosterbeek et al. 2004). The latter result suggests that people may be seeking outcomes that balance absolute and relative payoff. This result is also strongly related to cultural conceptions of fairness and obligation and reflects the propensity of people to exhibit both self-serving and other-serving behavior.

Biologists have long known that it is relative—not absolute—fitness that determines evolutionary outcomes; this may also explain the importance placed on fairness in human social groups. Exploring when and under what circumstances absolute or relative payoffs prevail and how that prevalence influences perceptions of fairness and the adoption of cooperative strategies would be an important contribution to the literature.

5. The role of viscous (i.e., slowly changing) and fluid (i.e., rapidly changing) norms and behaviors. Biologists have long grappled with the paradox of viscosity (Ehrlich and Levin 2005). Organisms must balance the need for evolutionary innovation (mutations) required to adapt to changing and novel conditions with the need to maintain a functioning phenome. This requires a balance between adaptability and stability, between rapid change and conservatism. The need for conservatism may, at times, impose suboptimal strategies on organisms with respect to extant conditions.

We see many of the same dynamics in the emergence and maintenance of norms. Many norms persist even after they appear to have outlived their usefulness (Elster 1989), but this conservatism may be playing an important role in maintaining a culture or society. When is rapid change beneficial, when is conservatism beneficial, and what viscosity exists in the capacity of cultures to switch between the two? Does it benefit society to have some behaviors and norms be fluid, while others are viscous, and, if so, which behaviors and norms can tolerate fluidity? What does this mean for the policy interventions that governments might make to alter behaviors?

Conclusions

Much of the political debate on particular policy instruments is focused on their near-term efficacy or popularity. In light of the above discussion, however, it is clear that structural changes need to be made that would allow society and policymakers to more effectively assess the longer-term implications of policy proposals. Initially unpopular or only modestly popular measures may gain wider acceptance if they prompt reinforcing changes in how people define themselves and their society, particularly if the changes are aided by innovations that make their implementation easier or more effective. For instance, a poll of American opinions on global warming suggested that the public by and large opposes taxes on gasoline or electricity as a way of combating global climate change and, instead, favors stricter fuel- and building-efficiency standards (Leiserowitz 2009). Although standards may be the path of least resistance, many environmental economists view taxes and other market-based instruments as a more efficient means to internalize the external costs of consumption. Political scientists have found that people have come to accept other taxes as normative after they have been convinced that the taxes effectively address shared concerns (Bobek et al. 2007). A carbon tax might therefore prove effective even in the face

of near-term opposition. What needs to be assessed is the possibility that behaviors and values would coevolve in such a way that a carbon tax—or other policy instrument that raises prices, such as a cap-and-trade system—ultimately comes to be seen as worthy, which would therefore allow for its long-term effectiveness.

We have some scientific understanding of many of these issues but not nearly enough, and the application of our scientific understanding of how policies influence social norms is inadequate. The academy, therefore, needs to increase its capacity to work with policymakers to effectively use existing knowledge on policy–behavior–norm interactions and to generate needed new insights in a timely fashion.

We have three recommendations for improving this process: (1) the greater inclusion of social and behavioral scientists in periodic environmental policy assessments; (2) the establishment of teams of scholars and policymakers that can assess, on policy-relevant timescales, the short- and long-term efficacy of policy interventions; and (3) the alteration of academic norms to allow more progress on these issues.

The academy has extensive experience with policy-relevant environmental assessments, including, for example, the assessments conducted by the Intergovernmental Panel on Climate Change (IPCC), the Millennium Ecosystem Assessment, and the Global Biodiversity Assessment. Achieving any progress on intractable global environmental issues such as climate and biodiversity change will require changes in behavior and social norms, but environmental assessments often include sophisticated biogeophysical models and analyses and less sophisticated (or absent) social and behavioral models and analyses (Reid et al. 2010). This imbalance calls into serious question the plausibility of projections of the (human-dominated) Earth system. These assessments need to be augmented to systematically examine the behavioral implications of potential environmental policies and environmental changes, using both case studies and more generalized syntheses and theoretical evaluations (Alston 2008). The Millennium Ecosystem Assessment has, for instance, spawned efforts to establish the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services with considerable input from the social sciences (Perrings et al. 2011); more integration of this sort is needed. The emerging Millennium Alliance for Humanity and the Biosphere provides another potential platform for bridging these gaps and developing foresight intelligence (Ehrlich and Kennedy 2005). Although the IPCC has long incorporated the social sciences, the minimal role of the behavioral sciences, while still modest, has notably expanded in its Fifth Assessment, now under way. Funding agencies should consider withholding support for assessments that are not sufficiently inclusive of social and behavioral sciences; a more constructive approach might entail including resources and support for designing effective collaborative processes in addition to the resources for conducting the assessment itself. This support might include

examining the norms and practices that currently preclude such inclusion, with insights into best practices for breaking them down.

Assessments are generally conducted within the academy, after consultation with policymakers regarding their scope and remit. But a persistent gap between science and policy remains, and filling that gap will require new innovations in academy–practitioner collaborations, including greater and more intensive collaboration among the producers and users of knowledge (Sarewitz and Pielke 2007). The academy should work with policymakers at all levels to establish, deploy, and support teams of scholars and policymakers to evaluate the potential impacts of different policy interventions on behaviors, social norms, and intended outcomes. These teams would be characterized by equally important (but different) roles for the academics and policymakers and should increase both the capacity of scientists to conduct policy-relevant research and of policymakers to understand the nature and dynamics of complex systems. They would differ from assessments in the timescale on which they are operating (e.g., an evaluation of near-term policies rather than longer-term forecasts of environmental change) and in the greater intensity of collaboration between scholars and practitioners than what characterizes most assessments. Teams might be supported by permanent entities that maintain communication with policymakers; these will differ among nations but could be attached to the United Nations and its subsidiary bodies in the international context. One potential model is a national commitment of scientific talent in the service of United Nations agencies. Policymakers at national and international levels could convene these teams to tackle specific problems. To be effective, the deliberations should be transparent, and the results should be communicated to the appropriate sectors of the public. These teams could also be charged with anticipating crises and evaluating potential policy responses in advance, since detailed evaluation in the midst of a crisis may be problematic; such emergency preparedness would probably focus on the immediate effects of policies on behaviors rather than on changing social norms, because this is likely to be of greatest relevance in a crisis.

This will not be easy. Despite repeated calls for a more constructive relationship between scientists and policymakers, there are few innovative organizations or processes to improve collaboration (Driscoll et al. 2011). There have been some recent advances, including the IDEAS Factory, run by the Engineering and Physical Sciences Research Council in the United Kingdom and designed to bring stakeholders and scientists together in a facilitated, innovative environment, to increase the applicability of science to real-world problems. Similarly, the newly established National Socio-Environmental Synthesis Center in the United States seeks to increase the prevalence of actionable science (Palmer 2012). The success of both of these and of related efforts would require altering the way we do science and how we define the questions of interest.

In order to play an effective role, then, the academy will, itself, need to reflect on its own professional norms as potential obstacles to constructive engagement. The social norms of the academy have evolved to serve important ends but not necessarily ones relevant to facilitating societal responses to global challenges. Academic norms can also impede effective engagement and communication with the lay public (Fischhoff 2007). Just as the evolution of social norms can lag behind the needs of society as a whole, science may be behind the times in how it organizes itself and trains and rewards its members. Thought leaders in the academy need to draw on what we know from the research summarized above—including the roles of incentives and regulations, the interplay between behaviors and values, and the appeal to standards in communities outside of the academy with which academics may identify—to begin questioning and potentially changing existing academic norms (Ehrlich et al. 2012). Where this cannot be done or where it would compromise important goals of scholarship to do so, academic institutions need to establish new departments or institutes that can complement traditional academic strengths with greater societal and policy engagement. Such measures would have to come with the recognition that business-as-usual academic practices are unlikely to achieve the requisite integration; centers will have to be armed with new reward structures and knowledge of the best practices in integration if progress is to be made.

There is room for optimism. In much of the world, there is growing awareness that we face potentially catastrophic global environmental problems and that significant shifts in policies, technologies, and behaviors will be required to address them. Therefore, many people are primed to accept solutions that evoke social norms involving our shared responsibility to the environment and to other people, and many policymakers are searching for policies that can have long-term impacts on behavior and environmental outcomes. The academy needs to do what it can—and more than it is doing now—to deliver on this more promising environmental future.

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is a better place for having had her, and she will be deeply missed.

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