

The tragedy of cognition: psychological biases and environmental inaction

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In an ideal world, people would tackle major crises such as global climate change as rational actors, weighing the costs, benefits and probabilities of success of alternative policies accurately and impartially. Unfortunately, human brains are far from accurate and impartial. Mounting research in experimental psychology reveals that we are all subject to systematic biases in judgement and decision-making. While such biases may have been adaptive heuristics that promoted survival and reproduction in the Pleistocene environment of our evolutionary past, in today's world of technological sophistication, industrial power and mass societies, psychological biases can lead to disasters on an unprecedented scale. Beyond the exploding ecological and socio-economic research on climate change and how to deal with the 'tragedy of the commons', it is a better understanding of human psychology – 'the tragedy of cognition' – that may ultimately tip the balance against the seeds of our own destruction.

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Introduction

THE severe environmental problems facing the planet raise challenges for natural and earth sciences, but even greater challenges for psychology and the social sciences: how do we overcome the individualism, misperceptions, and biases that hinder recognition and prevention of environmental degradation among global citizens? Obviously, some of the difficulties involve the sorts of trade-offs involved in any public-goods conflict, with individuals pitted against the collectives of which they are parts – variants of the well-known 'tragedy of the commons'¹⁻⁴. Beyond this, however, we argue that people's attitudes to the environment can better be explained and predicted – over and above any actual facts about environmental change – by taking into account the psychological biases inherent to the human brain.

A growing body of research in experimental psychology and economics has revealed a number of systematic psychological biases – well-established and widely repli-

cated phenomena that are exhibited by mentally healthy adults⁵⁻⁹. These biases cause our judgements and decisions to deviate systematically from the predictions of 'rational choice theory' – the notion that people have stable preferences, and that they accurately weigh the expected costs, benefits and probabilities of alternative options, allowing them to select the most efficacious solution. Psychological biases have been widely identified as sources of mistakes, policy failures, and disasters in political and economic decision-making, ranging from the causes of war, to investment decisions, to the lessons people learn from history⁹⁻¹³. Notably, political leaders and experts are just as subject to psychological biases as lay people, especially when dealing with the cognitive demands of fast moving and complex events¹⁴⁻¹⁷. For example, Irmtraud Gallhofer and Willem Saris found that despite at least seven distinct strategies being on the table during the 1962 Cuban Missile Crisis, US decision-makers tended to consider only two at a time¹⁸.

In this article, we explore the impact of psychological biases on preferences, perceptions and reactions to environmental change. Do psychological biases lead to systematic misperceptions about environmental change and our role in it? What are the likely consequences of such biases? What can be done to correct or avoid such biases? Building on models developed in political science^{10,19,20}, we examine how human preferences, perceptions, and reactions to environmental change are influenced by human sensory and psychological biases, and how these are further exacerbated by biases at the organizational and political level. We focus on five of the most important psychological biases – positive illusions, cognitive dissonance, the fundamental attribution error, prospect theory and in-group/out-group bias.

The bad news is that all of these psychological biases lead people to downplay the probability and danger of environmental change, and their role in it, while increasing their perceived incentives to maintain the status quo, and to blame problems on others. Discounting plays a huge role: people are relatively insensitive to long-term and hypothetical dangers such as future environmental degradation and climate change, and much more sensitive to immediate and concrete personal experience such as floods and earthquakes. This converts personal perceptions of vulnerability, symbolic events and elite (high-

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ranking political or opinion leaders) and media manipulation into highly significant and non-rational influences on people's attitudes towards the environment. Much effort by environmentalists is focused on explaining and disseminating scientific facts. We suggest that the greater struggle should be making facts *salient* to a collection of largely uninterested, distracted and biased human brains.

The good news is that because psychological biases are systematic, not random, it should be possible to identify their causes and consequences and tailor political, economic, and social policies that channel people's preferences away from disaster.

Psychology and the environment

Despite significant advances in our understanding of human psychology, the human brain rarely attracts much attention in debates over environmental politics, nor indeed many other political domains^{9,15,21}. In the realm of environmental change, the focus of the debate is (rightly) on facts, figures and predictions – these are the things we need to measure and analyse to assess the state of the environment, how it is changing over time, and what needs to be done to avert irreversible damage. But an important perspective missing from this burgeoning research area is whether we, as humans with human brains, are properly equipped to accurately conceive of the threat^{22,23}. Environmental change is largely invisible, very long-term, hypothetical, uncertain, and controversial, while efforts to deal with it threaten everyday social and economic demands – ‘going green’ constrains our time, money, opportunities and desires²⁴. Psychological biases – as products of evolution to promote individual survival and reproduction – are therefore prone to oppose helping the future environment at the expense of the immediate self.

One reason that the psychological dimension has been overlooked is the pervasive dominance of rational-choice logic in academic and journalistic reporting. Decades of work in psychology has long shown the rational choice paradigm to be a poor descriptor of human behaviour. Yet, both economics^{13,25,26} and political science^{27–29} have been loath to discard the clean rational-choice paradigm for the messier and more complex reality of human nature. This situation is changing, however. The rise in recent decades of novel security threats – terrorism, ethnic violence, immigration, pandemic diseases, resource conflicts and environmental threats – have led to dissatisfaction with many social science models that previously held sway. In their place, there has been a resurgence of interest in the key role of human nature^{9,15,21,30,31}. Psychological approaches not only shed new light on old puzzles in politics, economics and sociology, but also suggest novel – and sometimes counter-intuitive – policy recommendations^{22,32}.

Assessing the role of human nature in environmental policy remains both understudied and urgent. A recent review of perceptions of climate change found that ‘Society at large does not appear to be deeply concerned with global warming, and as a result, is not yet acting on the ever-more urgent warnings emanating from the science and advocacy communities. Despite encouraging signs, ignorance, disinterest, apathy and opposition are still prevalent’³³ (p. 3). As these authors point out, ‘lack of a widespread sense of urgency is not the result of people not knowing about the issue. It is also not just due to not understanding it or lack of information’³³ (p. 3–4). In fact, over 90% of people are aware of global warming in the US – often touted as one of the countries least concerned about the issue, despite churning out 25% of the world's CO₂ emissions with 5% of its population³⁴. There are also strong majorities in support of global environmental mitigation policies. The puzzle, however, is that while people are aware of the problem and many judge it to be serious, only around a third of Americans find the issue personally concerning. Polls at the turn of the millennium found that the environment ranked 16th among the most important problems facing the country, and global warming ranked 12th out of 13 *environmental* issues³⁴. ‘Clearly’, Dilling and Moser conclude, ‘there is something in *how* we communicate climate change that is failing to mobilize a wider audience’³³ (p. 4).

While Dilling and Moser address the problem of how to improve the communication of climate change, in this article we focus on judgement and decision-making biases *that remain a problem even if communication is good* (see Figure 1 for a scheme of the key barriers to effective environmental action). While political, economic and social change becomes ever more critical, powerful biases favour the status quo: (1) *Sensory biases* shield our attention from dangers that remain distant or hypothetical; (2) *Psychological biases* entrench familiar, established, or psychologically convenient mindsets; (3) *Organizational biases*, bureaucratic processes, and vested interests resist changes even if they are wanted or demanded, and (4) *Political biases* provide little incentive for expensive and disruptive preparation for uncertain and often invisible threats. Each of these four categories of bias, significant on their own and especially severe in combination, is addressed in turn below. In the worst case scenario, disasters may be ‘required’ before people are willing to bite the bullet and enact drastic environmental policies to stave off irreversible climate change.

Sensory biases

A number of sensory and physiological biases predispose us to maintain the status quo, and to avoid expending resources on threats outside our direct realm of experience. Humans have a biological predisposition to react to

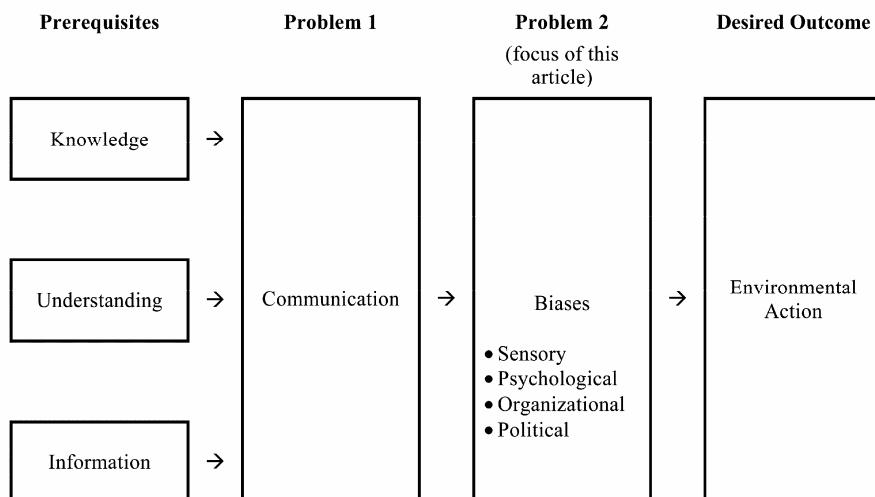


Figure 1. Knowledge, understanding and information are prerequisites for action on climate change, but even if each of these is in place, motivation may fail for two further reasons: (1) poor communication; and/or (2) sensory, psychological, organizational, and political biases that undermine effective action.

stimuli that reach our five senses (sight, hearing, taste, smell and touch), and not to stimuli that remain beyond our personal experience. The machinery of the brain does not fully react to something until we detect it in the flesh. This is not surprising – our sensory organs, cognitive architecture, and mental processing evolved in order to respond to real threats and opportunities in our immediate local environment, not to abstract, vague, distant or hypothetical threats that happen elsewhere, or to other people^{35–37}. Moreover, the time lag between the actions we take today and the consequences for the future fails to provide direct sensory feedback, and greenhouse gases, ozone and deforestation on distant continents are effectively invisible. Of course, our brain does generate vicarious emotional reactions to events that we observe at-a-distance or that we learn is happening to others, but not as powerfully as experiencing them for ourselves³⁸.

For example, there is historical evidence that actually seeing nuclear tests in the early part of the Cold War had a powerful effect on people’s aversion to war and the subsequent non-use of nuclear weapons³⁹ (p. 14). Survey research shows that Americans see climate change as a ‘moderate risk that will predominantly impact geographically and temporally distant peoples and places’³⁴ (p. 44). Many western populations generally perceive themselves as distant from nature – even in their local environment. For example, a recent study of Native Americans and European Americans living in the same rural area showed that, despite having equivalent *knowledge*, very different ‘epistemological orientations’ affected memory organization, ecological reasoning and the perceived role of humans in nature, all of which led to quite different approaches to resource conflicts and science⁴⁰. ‘Critically’, Leiserowitz concluded, ‘most Americans lack vivid, concrete, and personally relevant affective images of climate change’³⁴ (p. 50). All sorts of salient events can alter the

perception of safety or danger – floods, wild fires, knowing family or friends who are affected, etc. Dramatic events may not necessarily be valid indicators of what is happening, or what is to come. The point is, however, that events can take on a powerful symbolic significance, and while they may not in themselves represent evidence of a statistical pattern, they nevertheless heavily influence people’s perceptions. This is particularly significant for climate change, because people commonly confuse the concepts of climate and weather⁴¹.

Also significant is the general principle, across a wide range of psychological phenomena, that *negative* events and information are processed more thoroughly and have greater impact than positive events, and *negative* impressions and stereotypes are quicker to form and more resistant to disconfirmation than positive ones⁴². In terms of the overall effects of personal experience, a review by Baumeister *et al.* concluded, ‘bad is stronger than good’. In international politics as well, failure, as opposed to success, appears to have an intrinsic leverage: ‘People learn more from failure than from success – past success contributes to policy continuity whereas failure leads to policy change’⁴³ (p. 304). This difference may also explain why people often *do* invest in long-term risks and opportunities when they are dealing with more *positive* events, such as financial savings, advanced education, or property.

Finally, issues can be made salient or symbolic via elite or media manipulation. There is good evidence that the media has a strong influence on people’s perceptions of the environment. In a cross-country analysis, for example, Allan Mazur found that public perceptions of environmental dangers correlated with the quantity of news coverage on those topics⁴⁴. This becomes a problem, of course, if the media is biased. Market forces dictate that news inevitably stresses some events and downplays

others. As the science editor for UK tabloid *The Daily Mail* put it, 'The problem is that the effects of climate change mostly haven't happened yet . . . Talking about what the weather may be like in the 2100s, never mind the 3100s, does not sell'⁴⁵ (p. 20). Consequently, dramatic events like Hurricane Katrina dominate the news, while less dramatic but more significant harbingers of long-term environmental change, such as the gradual melting of the polar ice sheets, do not capture people's attention.

In summary, we are most likely to react to a threat: (1) if it reaches us through first-person experience (rather than via newspapers, radio or television) and (2) if it is a negative event (such as a disaster) rather than a positive one. It may therefore require catastrophes on the scale of Hurricane Katrina – unrepresentative of general patterns as they maybe – to surmount our sensory barriers, acknowledge major new threats, and goad us into action⁴⁶.

Psychological biases

Experimental research in cognitive and motivational psychology reveals a vast array of biases in judgement and decision-making, many of which tend to preserve the status quo – avoiding change and discouraging us from expending resources on threats outside our realm of perception⁵⁻⁹. These biases include: the 'mere exposure effect' (a preference for things that are more familiar); the 'availability heuristic' (a tendency to make predictions that are biased by recent experience); the 'bandwagon effect' (a tendency to do or believe the same as others); the 'projection bias' (a tendency to assume that others share similar beliefs to oneself); the 'false consensus effect' (a tendency to expect others to agree with oneself), and 'discounting bias' (to prefer immediate over long-term rewards).

Although all such biases are potentially important for environmental change, this article will focus on five major biases that are among the most well-established in psychology and have been widely applied to explain decision-making failures in politics and economics: positive illusions, cognitive dissonance, the fundamental attribution error, prospect theory and in-group/out-group bias. Each bias is outlined in Table 1 and its consequences for the environment discussed below.

Positive illusions

People tend to have 'positive illusions' about their abilities, their control over events, and of the future, all of which lead to overconfidence about their vulnerability to risk, and therefore to discount the need for change⁴⁷⁻⁵⁰. Positive illusions have long been cited as a cause of policy failure and disasters in politics and economics^{12,51-54}. For example, many have argued that biases towards overconfidence contributed to the outbreak of the First World

War in 1914 and the Iraq War in 2003 (refs 55–57). Nobel laureate Daniel Kahneman recently noted that, of all the psychological biases documented over the last 40 years, all of them tend to favour 'hawkishness' – a tendency to exacerbate self-interest and conflict^{58,59}.

For the environment, positive illusions mean that people are likely to overestimate their ability to avoid or cope with environmental degradation, downplay the probability of being personally affected by it and overestimate their ability to control events even if things go badly. As Daniel Goleman put it, despite their vaunted advantages at the personal level, positive illusions are 'toxic for us as a species . . . We fool ourselves so easily about the dangers to our species because our illusions work too well. While our emotional and physical well-being is based in part on artful denial and illusion, the state of the world is such that we can no longer afford that artifice'⁶⁰ (p. 190–191). Environmental optimism is often inadvertently encouraged by the media practice of always presenting two sides to an issue. Irrespective of the hefty scientific consensus on climate change, a contradictory view can always be found. Media attention may also play a counter-productive role because skeptics cite media 'dramatization' as evidence that an issue is rising only in fashion and not in reality.

When are positive illusions more likely? Experimental psychologists have found that positive illusions are more likely in situations of ambiguity, lack of feedback, and threat^{12,52,61,62}. This is a recipe for disaster with environmental issues, because climate predictions, for example, are highly ambiguous, feedback will come only over the course of decades, and the threat is rising.

Harking back to the importance of sensory biases, once one is personally involved in a disaster, optimistic illusions can disappear. One study found that Californians' positive illusions about the risk of earthquakes decreased significantly after they had actually lived through one⁶³. The effect appears to extend to a wide range of threats. Yechiel Klar *et al.*'s study of Israelis living with the threat of terrorist attacks found that people maintain positive illusions as long as threats are 'hypothetical' and 'psychologically unreal'. But, 'when the group to which people belong is the target of some significant ongoing calamity, even when the participants themselves are currently not the direct victims, the unreality of the event dissolves and optimism (both absolute and comparative) decreases or vanishes altogether'⁶⁴ (p. 216). Disasters serve to wake us up to reality. They are very effective at doing so but, by definition, the wake up call comes too late.

Cognitive dissonance

Contradictory information generates psychological discomfort, and as a result people subconsciously: (1) try to make dissonant information fit their existing beliefs and

Table 1. Five major psychological biases among healthy adults

Bias	Description	Promoters	References
Positive illusions	<ul style="list-style-type: none"> • Over-estimation of capabilities • Illusion of control over events • Perceived invulnerability to risk 	<ul style="list-style-type: none"> • Ambiguity • Lack of feedback • Threat 	47–50
Cognitive dissonance	<ul style="list-style-type: none"> • Dissonant information made to fit preferred beliefs • Avoidance of situations that increase dissonance 	<ul style="list-style-type: none"> • Contradictory information • Commitment to a given policy • Strong preferences • Ideological motives • Powerful threats to interests • High stakes 	65, 66
Fundamental attribution error	<ul style="list-style-type: none"> • Attribute others' behaviour to intentional action • Attribute own behaviour to situational constraints 	<ul style="list-style-type: none"> • Observations of others' behaviour (especially unusual behaviour) • Poor communication • Distrust • Bad experiences in past interactions 	67, 68
Prospect theory	<ul style="list-style-type: none"> • Risk-aversion when choosing among potential gains • Risk-proneness when choosing among potential losses 	<ul style="list-style-type: none"> • Available options perceived as bad • High apparent costs • Low apparent benefits • Feeling cornered 	69, 70
In-group/out-group bias	<ul style="list-style-type: none"> • In-group seen as favourable and superior • Out-group seen as unfavourable and inferior 	<ul style="list-style-type: none"> • Categorization into groups • Perceived inter-group threats • Low information flow between groups 	72, 73

(2) actively avoid situations that increase dissonance. The phenomenon of ‘cognitive dissonance’ therefore tends to select, organize or distort conflicting information so that it matches our preferred or pre-existing beliefs^{65,66}. Cognitive dissonance appears to be subtle yet powerful – we are often quite unaware that we are passively excluding or discounting uncomfortable information from our thoughts.

For the environment, cognitive dissonance means that people (at least in many Western, developed nations) may be unable to reconcile the safety they perceive around them in their everyday lives with the images of natural disaster they see in the news media or in forecasts for the future. Informing people that the lives and locations they have come to know will be subject to radical change cannot be readily visualized and is likely to be rejected or distorted as dissonant information.

When is cognitive dissonance more likely? Cognitive dissonance is likely to increase with several factors related to the environment: contradictory information (there are always differing opinions as to likely outcomes or the best strategies to avoid them), commitment to a given policy, strong preferences, ideological motives (staunch opinions about environmental issues block alternative viewpoints), powerful threats to interests, and high stakes (people’s livelihoods, property and prosperity are ultimately on the line).

Fundamental attribution error

People tend to attribute the behaviour of others to ‘dispositional’ causes (their characteristics, personality or inten-

tions), while one’s own behaviour is attributed to ‘situational’ causes (such as limited choices, necessity or competing concerns)^{67,68}.

For the environment, this means that people are likely to perceive the actions of organizations, governments and other groups in society as acting in their own interests (via raising taxes, imposing carbon limits, free-riding on the efforts of others, etc.), while reducing one’s hard-won freedoms or prosperity in the process. At the international level, members of one nation are likely to perceive their own efforts at environmental policy as working against numerous difficult constraints, whereas they will perceive other nations as shirking environmental policies to get ahead, oblivious or dismissive of those other countries’ own unique or similar constraints. China, for example, gets heavy attention in the US news media for its burgeoning consumption rates, but little attention on its environmental schemes.

When is the fundamental attribution error more likely? This bias is likely to be worse when attention is focused on others’ behaviour (e.g. during international disputes or following disasters), when communication is poor (often the norm between different cultures), when distrust is high (exaggerating these effects between rivals or enemies) and following bad experiences in past interactions (thus perceiving certain nations as incorrigible polluters or ‘problem’ states).

Prospect theory

When facing uncertain outcomes, people are risk-averse when choosing among potential gains (the ‘domain of

gains'), but risk-prone when choosing among potential losses (the 'domain of losses'). Thus, people tend to gamble more when facing bad choices^{69,70}.

For the environment, this means two things. First, in general we are arguably now in the domain of losses: either we make costly changes to our lifestyles, or we do nothing and face the prospect of major environmental disasters. Other things being equal, prospect theory predicts we will be risk-prone in this situation, gambling on doing nothing in the hope that things will not be as bad as all that. Poor planning for Hurricane Katrina may be an example – choosing to avoid costly improvements to flood defenses in the hope that they would not be needed.

Second, the predictions of prospect theory completely depend on the decision-maker's perception of the relevant costs and risks: one study argued that President Bill Clinton saw himself in a domain of losses (because of impending environmental costs) while George W. Bush saw himself in a domain of gains (because of impending economic growth). Consequently, Clinton was considered here as risk-prone in pursuing the Kyoto protocol, given the inherent uncertainties and costs of the treaty for the U.S. economy⁷¹. Perceptions thus play a role in whether, when, and how Prospect Theory influences environmental policy preferences across different people and circumstances.

When are Prospect Theory preferences more likely? Risk-proneness is more likely when the available options are bad, or appear bad (ironically, it may be important to maintain an element of optimism about change); when there are high apparent costs and low apparent benefits (so that available options appear worse); and when there is a sense of being cornered (in which case escape routes appear foreclosed and only bad options loom).

In-group/out-group bias

One of the most well established cognitive biases is the 'minimal group paradigm', in which even randomly and arbitrarily formed groups show a tendency to evaluate one's own in-group and its members favourably, while disparaging out-groups and their members^{72,73}. Social identity theory describes this as a process by which group members seek self-esteem through favourable comparisons with other groups.

For the environment, in-group/out-group biases can be particularly significant, because effective environmental action depends on the cooperation (or at least coordination) of many different groups and nations¹. These efforts are easily undermined by perceived injustices, blame casting, and scapegoating of the causes and consequences of environmental change – all of which are exacerbated by in-group/out-group biases. People in country A will tend to view their own consumption as deserved, long-established, and difficult to change, whereas they will

tend to view consumption in country B as wasteful, unnecessary and exploitative. Americans often point to China as having greater overall CO₂ emissions than the US, but fail to reconcile this with the fact that the average American's *per capita* carbon footprint is about four times higher⁷⁴. It is effectively an argument over who should have what lifestyle, not over the responsibility for emissions *per se*⁷⁵.

When is the in-group/out-group bias more likely? The in-group/out-group bias is more likely when there is strong categorization into groups, large actual or perceived inter-group threats and low information flow between groups. This is bad news for global efforts to contain environmental change, where cultural boundaries are vast, a range of security threats feed rivalry and suspicion, and understanding and feedback about other nation's problems are low – fertile ground for in-group/out-group biases to prosper.

To summarize, the five common psychological biases examined above bode ill for environmental protection. All of them lead people to downplay the probability and danger of environmental change, and their role in it, while increasing their perceived incentives to maintain the status quo, and to blame problems on others. There are interesting interaction effects as well. Positive illusions can make the bad options in Prospect Theory's domain of losses seem all the more worth the risk (going for broke and hoping for a miracle). The fundamental attribution error can exacerbate in-group/out-group biases by making other groups successes look like chance or luck, while one's own efforts are put down to hard work and skill. While any one bias on its own, therefore, may lead to significant hurdles in forming, selling and enacting environmental policies, in combination the problems are magnified.

If this paints a pessimistic picture, the problem is larger yet. On top of sensory and psychological biases acting on individuals, there are fundamental factors impeding political, economic and social change at the level of society as a whole. First, change is hard to assess – major disasters are rare and the consequences of preemptive strategies are unknown. Second, change brings uncertainty – if the status quo has worked until now, why risk uncertain policy outcomes over familiar ones? Third, change entails costs – the reorganization or acquisition of extra resources adds weight to the argument to do nothing. Surrounding these three basic factors, a failure to change is powerfully exacerbated by biases at the organizational and political levels. These are briefly examined in the final two sections.

Organizational biases

Numerous organizational and institutional biases predispose us to maintain the status quo, and to avoid expend-

ing resources on threats outside the realm of established conventions. Organizations – large groups of people that work towards common goals – are subject to bureaucratic inertia, fixed standard operating procedures, vested interests, competition for promotions, sunk costs, access to the elite, and turf wars over budgets and responsibilities. All of these phenomena favour a rigid focus on past experience and successes, and a rigid avoidance of rocking the boat to advocate some new and unproven revision of policy^{76–78}. An entire literature has built up around this ‘bureaucratic politics model’ of decision-making – often a default explanation for costly or failed policies. Many organizational biases derive from characteristics that are to some extent intentional: ‘the value of institutions typically lies in their persistence or “stickiness”, which allows actors to make plans, invest and organize their affairs around institutions and, in general, lends certainty and predictability to their interactions’⁷⁹ (p. 5).

Often, however, the costs outweigh the benefits. Prior to 9/11, for example, the infrastructure, professionals and mindsets of the Cold War era still exerted a significant legacy in the US intelligence community. There was a ‘failure of imagination’ – a dearth of lateral thinking or fresh ideas – even though the threats of transnational terrorism had long been evident^{80,81}. In addition to the failures to actually plan for novel threats, Stephen Van Evera has laid out reasons why institutions have little incentive to self-criticize or even evaluate their own performance in the first place⁷⁷. The entire institutional environment is hostile to adaptation: ‘Myths, false propaganda, and anachronistic beliefs persist in the absence of strong evaluative institutions to test ideas against logic and evidence, weeding out those that fail’⁷⁷ (p. 163).

A further problem with organizations is that the ‘sensors’ – the people with their ears to the ground – are disjointed from the decision-making structure (in an interesting corollary to the sensory biases noted above). Leaders are sometimes the last to know about impending (or even actual) disasters. The middle managers or those below them are the ones who deal on an everyday basis with the outside world and are, therefore, more likely to detect novel threats, or to recognize that old methods are no longer appropriate. When a minor flaw was found in the Pentium Processor in 1994, for example, Intel suffered half a billion dollars damage in less than six weeks. The fault caused a rounding error in division once every nine billion times, but this tiny flaw quickly became significant – the news spread rapidly on the internet and was amplified by Intel’s new global prominence and identity. According to Intel CEO Andrew Grove, ‘I was one of the last to understand the implications of the Pentium crisis. It took a barrage of relentless criticism to make me realize that something had changed – and that we needed to adapt to the new environment’⁸² (p. 22). Similar failures of problem detection, safety mechanisms and leadership are evident in many environmental disasters as well,

ranging from the Exxon Valdez oil spill to the woefully inadequate response to Hurricane Katrina.

Political biases

The nature of politics also predisposes us to maintain the status quo, and to discount genuinely important threats in favour of politically salient ones. There is no reason to expect efficient adaptation (or sometimes any adaptation at all) to address emerging dangers. Politics provides numerous alternative motivations for individual leaders, political parties, lobby groups, the media and voters to steer policy and incentives in their own preferred direction, often to the detriment of adaptation to genuine threats^{20,32,78,83}. The reality of politics means that radical shifts in policy, especially towards a novel or hypothetical threat (about which the evidence may be complex, uncertain or at least controversial), are often indefensible in congress, hard to obtain the necessary budget to initiate or complete, and politically suicidal. There are few points to be scored (or as many to lose) in pushing for rapid or comprehensive change, or for admitting mistakes. As long as the threat is at least four years away, or can be blamed on extraneous causes or opposing political parties, other concerns are likely to take precedence. Because discount rates vary somewhat among individuals, there is a risk of a double whammy effect here: a political leader with high discount rates operating in an already high-discount political environment may be especially predisposed to downplay environmental problems.

Incumbency is an important component of this problem. A high turnover of civil servants or politicians allows for regular and gradual adaptation to changing circumstances over time. By contrast, a low turnover reduces the ability and inclination to adapt, gradually bottling up problems until the whole system collapses under the pressure of a major disaster (like the Federal Emergency Management Agency (FEMA), after Hurricane Katrina). In the US government, a number of factors operate to empower incumbents and entrench particular elites and procedures. Disasters maybe particularly effective at bringing down an incumbent regime, whose failings – real or perceived – often become a central motivation and electoral strategy for opposition parties, congressional inquisitions and voters⁸⁴. A recent example is the ousting of 11 years of conservative rule in Australia under global-warming skeptic Michael Howard, with the new government’s core manifesto including ratifying the Kyoto protocol. Not coincidentally, the election followed one of the worst droughts in the country’s history.

Conclusions

Numerous features of human nature and the nature of institutions that humans create, limit our ability to detect

and react appropriately to novel threats. Because these features stem from independent sources at different levels of analysis (e.g. individual behaviour, organizational behaviour, elite decision-making, etc.), they are likely to generate a status quo bias across a wide range of circumstances. For example, even a forward-looking bureaucracy may run up against a reluctant public or a short-sighted political leadership. To put it bluntly, society seems predisposed to preserve the status quo until something goes wrong. As Dilling and Moser summed it up: 'the inherent natural characteristics and deep societal roots of climate change stack the deck against the issue being recognized as an urgent and actionable problem'³³ (p. 8).

We suggest that sensory, psychological, organizational and political biases are a powerful influence on people's preferences, perceptions and reactions to environmental change. The good news is that because these biases are systematic, not random, with known sources of variation, it will be possible to identify their causes and consequences and design political, economic and social policies that channel people's biases away from disaster.

Of course, while everyone is subject to the same biases, there are considerable differences in how they are manifested among different types of people. Again, however, it is possible to identify systematic patterns afflicting particular groups. Leiserowitz³⁴ (p. 51), for example, found that Americans who perceived climate change as a low or non-existent danger tended to be 'predominantly white, male, politically conservative, holding pro-individualism, pro-hierarchy, and anti-egalitarian values, anti-environmental attitudes, distrustful of most institutions, highly religious, and to rely on radio as their main source of news'. 'Alarmists', on the other hand, who perceived climate change as a high or extreme danger, were 'politically liberal, strongly supported government policies to mitigate climate change (including raising taxes), and were significantly more likely to have taken personal action to reduce greenhouse gas emissions'³⁴ (p. 53).

Several other factors suggest individual variation in preferences, perceptions and reactions towards long-term environmental change, including: scientific knowledge and understanding; training; profession (farmers in water scarce Australia, for example, are very concerned about global warming); experience; upbringing; socio-economic status; ideology; neurological differences in emotional or rational thought processing, and genetic factors underlying political preferences^{85,86}. Such factors suggest that we should expect considerable variation among individuals. However, the broad sensory, psychological, organizational and political biases outlined above nevertheless predict common factors that shift even divergent perceptions and preferences in common directions.

The interaction between well-established psychological biases and such socio-economic, political and personality characteristics offers much grist for the mill of future

research. Experimental psychology offers the opportunity to: (1) better explain different groups' attitudes towards the environment; (2) predict how they will respond to future scenarios; and (3) tailor policies that channel common psychological dispositions in advantageous ways. Of course, many politicians, lobby groups and advertisers already implicitly recognize these human foibles and exploit them relentlessly for their own ends. We think it could be a powerful weapon for the environmentalist agenda as well.

What are the prospects for the future? An awareness of psychological biases is likely to become increasingly important. There is a growing mismatch between our psychology – a psychology that evolved to deal with small groups of human beings in a very different social and physical environment – and the increasingly technological and globalized world we inhabit. As human interactions are increasingly replaced by human-computer interfaces for shopping, working and entertainment, we are gradually preventing natural sensory feedback to the brain. This means that the causes and consequences of our decisions and actions often fail to trigger the appropriate human responses. Simply put, we see less and less of the results of our actions, even as they have a larger and larger impact on the globe.

Even winning environmental battles may encourage psychological biases to prosper. As Pacala *et al.* note, 'many warnings of environmental scientists will prove to have been unfounded, and others will have led to actions that prevented or mitigated the predicted dire consequences'⁸⁷ (p. 1187). This will make it difficult to convince people that urgent action was necessary in the past and is needed again now. The uncertainty inherent in predicting environmental change makes all of these problems particularly vexing²⁴. Policy makers constantly seek simple information that can be transmitted to voters, and this wreaks havoc with the cautious predictions inherent to scientific research – especially climate science. As climate researcher Lenny Smith pointed out recently, policy makers 'think we know much more than we actually know. We need to be more open about our uncertainties'⁸⁸ (p. 13).

While there is much we don't know, policy makers and environmentalists would be well advised to look beyond the hard sought facts and figures of climate change, and pay attention as well to the characteristics of human brains that will interpret (or misinterpret) this information. While research, extensive and reliable data, education, communication, and recognition of the 'tragedy of the commons' are all essential goals, we may also need to focus on how to make use of psychology so that people will react appropriately to the information they receive – however good or bad it may be. Leiserowitz³⁴ (p. 55) suggests that one should emphasize local and immediate effects of climate change, instead of doomsday predictions of a distant future: 'What is needed now are the concrete

details, images and stories of climate impacts – on people, places, economies, cultures and ecosystems – to fill out the picture, bring the issues to life, and help people understand the potential dangers for the rest of the world'. Current events are not necessarily caused by climate change, but they may nevertheless be one of the few ways to reliably trigger more urgent responses and break down the sensory, psychological, organizational and political barriers that are so effective at preserving our cozy bubble of safety.

Where effects are local and serious, people evidently have no trouble being as concerned about global warming as, say, the US is about Al Qaeda. Low-lying coral atolls in the Pacific, for example, are particularly vulnerable to sea-level rises. As the Prime Minister of Tuvalu declared to the UN General Assembly in 2003: 'We live in constant fear of the adverse impacts of climate change. For a coral atoll nation, sea level rise and more severe weather events loom as a growing threat to our entire population. The threat is real and serious, and is of no difference to a slow and insidious form of terrorism against us' (www.tuvaluislands.com/warming.htm).

History suggests that without experiencing direct negative consequences of our actions (and sometimes even with such experience), human societies often wait for disasters to occur before adapting to novel threats, whether they are disasters of national security, disease, starvation, poverty or environmental change^{19,89}. Even environmental skeptics, such as the controversial figure Bjorn Lomborg, agree with this central problem: 'We are rich enough to solve most of our problems, but if the past is anything to go by we certainly would not'⁹⁰. This does not bode well for the future. Even when a threat poses a clear and present danger, such as global climate change, political actors often do almost nothing to adapt to the threat until it is too late. Radical change may only come after people are woken up to the danger by enough – or big enough – disasters close to home. As a recent *New Scientist* editorial lamented: 'The world will one day act with urgency to curb greenhouse gases: the likely violence of the atmosphere's reaction to our emissions makes that inevitable. Climate change awaits its 9/11' (8 July 2006, p. 3). It seems, perhaps, that we are facing not so much a tragedy of the commons, but a tragedy of cognition.

Role of the Branco Weiss Fellowship

Dominic Johnson's work on the role of evolutionary psychology in political judgement and decision-making is generously supported by a Branco Weiss 'Society in Science' Fellowship. This fellowship has provided an extraordinary opportunity to conduct research on the boundary between two apparently distant disciplines: evolutionary biology and political science. Many political

scientists – and social scientists in general – are skeptical of evolutionary and biological approaches to human behaviour, and as such it is both difficult and risky to pursue this line of research within the normal framework and career structure of mainstream academic departments. The Branco Weiss Fellowship has allowed Dominic to forge ahead with this inter-disciplinary research despite the traditional obstacles. His fellowship project can be considered a 'proof-of-concept', in which he has five years of complete freedom to demonstrate – through his research output of articles, books and presentations – the usefulness, publishability and real-world applications of evolutionary biology to important questions in the political domain (including cooperation, conflict and war). The Fellowship has supported theoretical work developing novel hypotheses and predictions, empirical research projects to test specific hypotheses, and travel to present this work at the conferences of widely varying disciplines. Without a long-term Branco Weiss Fellowship, there is no way that Dominic would have been able to pursue his inter-disciplinary research so confidently or effectively.

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