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Assessing Risk in the Absence of Quantifiability

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Abstract

A substantial literature on risk perception demonstrates the limits of human rationality, especially in the face of catastrophic risks. Human judgment, it seems, is flawed by the tendency to overestimate the magnitude of rare but evocative risks, while underestimating risks associated with commonplace dangers. Such findings are particularly relevant to the problem of crafting responsible public policy in the face of the kinds of

threat posed by climate change. If the risk perception of ordinary citizens cannot be trusted, then it would seem logical to base policy decisions on expert judgment. But how rational, how trustworthy, are expert assessments of catastrophic risk?

I briefly review the limitations of conventional models of expert risk analysis, especially in dealing with the large uncertainties endemic to the risk of low-probability, high-impact events in the distant future. The challenges such events pose to the underlying assumptions of these analyses are severe enough to question their basic rationality. I argue that a conception of rationality premised on the bounded knowledge of experts and lay citizens alike, based on context appropriate heuristics, may help us in the search for a more trustworthy basis for decision making.

KeywordsBounded rationality;Catastrophe; Cost-benefit analysis; Ecological rationality; Fear; Gaze heuristic; Precautionary principle; Rational decision making; Risk; Uncertainty

<A>What is a Rational Response to Catastrophic Risk?<A>

<A>Introduction: The Standard View<A>

The question of how people perceive (and respond to) risk has received a great deal of attention in recent years. Research over the last three decades has claimed to show that, because of the "cognitive limitations" or "defects" of the brains we have evolved, we are prone to misestimating and misperceiving risk, tending, especially, to overestimate the magnitude of those risks that are highly evocative, and ignore less evocative ones.[1] As the author of a recent *Time* magazine article explains, "We pride ourselves on being the only species that understands the concept of risk, yet we have a confounding habit of worrying about mere possibilities while ignoring probabilities, building barricades against perceived dangers while leaving ourselves exposed to real ones" (Kluger 2006).

But how do we know which risks are the "real ones"? For this, we turn to experts who assess the risk of some hazard "objectively," i.e., by computing (a) the magnitude of the hazard, and (b) the probability that it will occur, and (c) multiplying the two numbers together. Ordinarily, however, people do not (even tacitly) perform such calculations; instead, they use various kinds of shortcuts (heuristics or "rules of thumb") that permit them to make rapid and intuitive, if biased, assessments. One such shortcut is the "availability heuristic" -- the rule of thumb by which people evaluate the probability of

[1] Which is of course not to deny the enormous variability existing among individual responses.

an event according to "the ease with which relevant instances come to mind" (Tversky and Kahneman 1973).

Cass Sunstein is a legal scholar who served as the administrator of the White House Office of Information and Regulatory Affairs (OIRA) under Obama, and he has been strongly influenced by the work of Daniel Kahneman and Amos Tversky. Sunstein is especially concerned with the difficulty of fashioning rational public policy in the face of the threat of disastrous events. Such events engage intense emotions, and these emotions (together with the "availability heuristic") lead us to "focus on the worst case, even if it is highly improbable" (Sunstein 2005, p. 35). Indeed, he writes, "when intense emotions are engaged, people tend to focus on the adverse outcome, not on its likelihood" (2005, p. 64). This disposition – to misestimate or to altogether overlook probabilities – has predictable costs. Especially, Sunstein argues, it inclines the public to overspend on regulations. His conclusion? Because ordinary people cannot be relied upon to make rational assessments of the risks they face, the protection of public welfare requires that regulatory policy be based on expert judgment and not on popular sentiment. The tacit assumption here is that experts *can* make rational assessments of the risks we face. However, a major part of my argument in this paper is that, for the kinds of risks posed by changes in systems as complex as that of climate, they cannot. Given what Herbert Simon called the bounds of human rationality, the analysis of such complex systems confronts us with uncertainties that cannot be quantified, and it is precisely in estimating the probabilities

of rare events with disastrous consequences that our usual modes of rational analysis fail us most miserably.

A common explanation for the disparity between lay and expert judgment is that biological evolution has endowed humans with two different systems for apprehending reality: one, most commonly used in everyday life, is nonverbal, experiential and rapid; the other, relied upon by experts, is analytic, deliberative, rational, and slow[2]--but reliable (or at least that is the presumption). Paul Slovic studies the role of affect in decision making, and argues that affect is a central characteristic of the experiential system. To most readers, this might seem simply to underscore traditional views of emotion as antithetical to reason, and ipse dixit, taken to account for the relative unreliability of the affect-based system. Sunstein himself often seems to accept such an account. But I am inclined to agree withSlovic. Slovicclaims that view is overly simplistic, and credits at least the possibility of a constructive role for emotion in decision making, especially in an uncertain and hazardous world. He writes, "Although analysis is certainly important in some decision-making circumstances, reliance on affect and emotion is a quicker, easier, and more efficient way to navigate in a complex, uncertain, and sometimes dangerous world" (Slovic et al. 2005, p. S35).

[2] It would of course be implausible to suppose that the actual methods employed in expert analyses are the products of biological evolution; rather, the implication here is that biological evolution endowed us with the capacities for such forms of reasoning.

Slovic is not alone. The relation between emotion and rationality has come in for extensive reexamination in recent years, and a number of authors have joined Slovic in this effort (see, e.g., De Sousa 1980; Elster 1998; Hanach 2002), often looking to findings of contemporary neuroscience for support where it has been argued that emotional responses – because they have been honed by evolution -- might at times be useful supplements (or even alternatives) to conventional understandings of rational decision making (see especially Damasio 1994 and Ledoux1996).

<A>The Problem of Fear<A>

Among all the emotions, the role of fear is surely the most controversial. Fear is also the emotion most obviously relevant to the threat of catastrophic events, and its relation to the misperception of risk has been a particularly prominent theme in these discussions. Slovic has emphasized the importance of what he called the "dread factor," arguing that differences between lay and expert estimates of the risk of serious hazards is due largely to lay tendencies to focus on catastrophic potential. "The higher a hazard's score on this factor …, the higher its perceived risk, the more people want to see its current risks reduced, and the more they want to see strict regulation employed to achieve the desired reduction in risk" (1987, p. 283).

Other studies have also cited fear as a factor that magnifies the perceived risk (see, e.g., Lerner et al. 2003). But

fear has also been a topic of concern as a *consequence* of heightened risk perception. As Franklin D. Roosevelt long ago reminded us, fear is something to be feared in and of itself. Sunstein agrees. He writes, "fear is a real social cost, and it is likely to lead to other social costs" (2005, p. 127); and elsewhere, "If information greatly increases people's fear, it will to that extent reduce welfare" (2005, p. 195). Reviewers of Sunstein's 2005 book on *The Laws of Fear* note that Sunstein clearly shares Roosevelt's concern: "In Sunstein's view, the major thing proponents of democratically grounded risk regulation have to fear, in essence, is fear itself" (Kahan et al. 2006, p. 1072). Moreover, Sunstein seems to represent what has become a common view among economists, cognitive psychologists, and lay readers of this literature,especially since 9/11. That shock gave rise to an enormous literature on the political abuses of fear, virtually all of which takes as its starting assumption the prima faciecounterproductivity of arousing public fear.

The "One Percent Doctrine" of the Bush Administration has come in for particular criticism, especially by those critical of the use of a "discourse of fear" to promote the US war on terror, and to justify the war in Iraq. In November, 2001, concerned about the possibility of a second attack, Vice PresidentDick Cheney argued: "If there's a 1% chance that Pakistani scientists are helping al-Qaeda build or develop a nuclear weapon, we have to treat it as a certainty in terms of our response. It's not about our analysis ... It's about our response" (Sunstein 2005, p. 62). From the standpoint of decision theory, such a policy would be impossible to endorse, but as a political strategy, it

was unarguably successful, promoting political decisions that would otherwise have been extremely difficult to defend. Later, as these decisions came to be regretted, the doctrine came under mounting criticism for inducing a "culture of fear" in the American public. As one commentator put it, "The war on terror has been about scaring people, not protecting them" (Younge 2010), and for this, the one percent doctrine was especially effective.

Sunstein(2006) has noted that Cheney appeared "to be endorsing a version of the Precautionary Principle … According to [which], it is appropriate to respond aggressively to low-probability, high-impact events," while also noting that the more familiar context in which the precautionary principle is generally discussed lies elsewhere – namely, in climate change. "Indeed," he writes, "another Vice President -- Al Gore -- can be understood to be arguing for a precautionary principle for climate change (though he believes that the chance of disaster is well over one percent)." In point of fact, climate change poses a multitude of risks of quite high probability, but for the present, I want to focus on risks so devastating that they threaten the survival of civilization as we know it – in short, on catastrophic risks that most experts judge to be of low, even if non-negligible, probability.

Here terrorism and climate change clearly share the same dilemma: how to rationally respond to the threat of such events; how much to spend and how aggressively to act in the effort to avoid catastrophic events. But the forms of action envisioned are quite different. Cheney envisioned a war on terror (and

Iraq); Gore thought about regulation. Also, to the extent that the precautionary principle is understood as a mandate to "do no harm," invoking that principle in the two contexts brings to the fore how very different can be the kinds of "harm" anticipated (or ignored). Clearly, for climate change, the political shoe is on the other foot than it is for terrorism. But Sunstein's criticism of this principle is more general: he seeks to base his critique on logic, not on politics.

Sunstein worries that reliance on the precautionary principle reinforces heuristics (like the availability heuristic) that lead both to excessive fear and neglect of more important risks. He argues that codifying that principle embodies distortions of risk perception that themselves "result in serious harm" (2005, p. 26), suggesting even that it might better be called the "paralyzing principle": "the real problem is that [it] offers no real guidance – not that it is wrong, but that it forbids all courses of action, including regulation" (2005, p. 26; see also Sunstein 2002). Every possible action, including regulation, risks doing harm to someone.

The bottom line: human judgment is flawed, and because of the fear they arouse, worst-case scenarios have an especially distorting effect on that judgment. For Sunstein, the solution is in the advice of professional analysts, and not of popular will. But this presupposes that expert analysis delivers rational assessments of what the risk "really" is. And the obvious question is: What notion of rationality is being invoked in these discussions? What is meant by real risk?

<A>Rationality: What Is It?<A>

Broadly construed, rationality refers simply to the exercise of reason, to the deliberative process by which humans draw conclusion. Decisions (or choices)follow from the conclusions they draw. In the specific context of decision making (especially in economics and political science) the term "rational" has come to be used to refer not to reasoning in general but to the particular kinds of reasoning required for analytic assessment of risks and benefits. A rational choice is (by definition) a choice in which benefits are optimized; it is based on an objective and quantitative assessment of all costs and benefits involved. Other choices may be based on reason, but they are suboptimal and, by definition, less rational. Thus, when students of human judgment ask how people *do* behave, they do so against a particular assumption of what ideally rational behavior would look like, of how people*should*behave. Much debate in economics has focused on the question of how closely human judgment actually does conform to the standards of rational choice theory; but my focusin this articlelies elsewhere. My aim is to challenge the normative assumptions of that theory(particularly as deployed in the analysis of highly complex systems with built-in inherent uncertainties) – as it were, to challenge the rationality of at least some of the de facto applications of that theory. For decades now, rational choice theory has provided the gold standard for American public policy;

my question concerns problems that render the definition of rationality on which rational choice theory rests insupportable.

OIRA, the office whichSunsteinrecentlyheaded, is responsible for vetting and approving all regulation proposed by any federal agency or department before submitting it for White House approval. It is mandated to base its recommendations on the regulatory principles as laid down by Executive Order. The most recent formulations reaffirm the basic principles laid down in 1993:

> <BQ>As stated in that Executive Order and to the extent permitted by law, each agency must, among other things: (1) propose or adopt a regulation only upon a reasoned determination that its benefits justify its costs (recognizing that some benefits and costs are difficult to quantify); (2) tailor its regulations to impose the least burden on society, consistent with obtaining regulatory objectives, taking into account, among other things, and to the extent practicable, the costs of cumulative regulations; (3) select, in choosing among alternative regulatory approaches, those approaches that maximize net benefits. (Obama 2011)<BQ>

The premises underlying both rational choice theory and cost-benefit analyses have been extensively critiqued -- by economists, philosophers, and other social scientists -- and on a variety of different grounds.[3] One line of argument began more

[3] For example, rational choice theory has been extensively criticized for its focus on self-interest, neglect of values, and for its neglect of the plurality (and often incommensurability) of human goals (see, e.g., Sen 1977; Nussbaum 1997; Nelson 2006); cost-benefit analyses for their failure to take into account the fact that costs and benefits are differentially distributed, with some paying the lion's share of the costs, and others reaping the lion's share of the benefits (see, e.g., Broome 2001); for the very effort

than 50 years ago with Herbert Simon. Simon argued that because of the finitude of both computational capacity and informational access, all rationality – including expert reasoning – is bounded. His goal was

> <BQ>to replace the global rationality of economic man with a kind of rational behavior that is compatible with the access to information and the computational capacities that are actually possessed by organisms, including man, in the kinds of environments in which such organisms exist. (1955, p. 99)<BQ>

"Bounded rationality" is the best we can achieve, and much of Simon's subsequent effort was devoted to developing models of how such bounded rationality would operate.

Central to this effort was his focus on how, in practice, behavioral choices depend not only on an actor's computational ability, but also on prior experience with the structure of the environment in which action is required. As he put it, "Human rational behavior ... is shaped by a scissors whose two blades are the structure of the task environment and the computational capabilities of the actor" (Simon 1990, p. 7).

More recently, GerdGigerenzer and his colleagues at the Max Planck Institute have taken up Simon's challenge and extended his efforts through years of careful observation of how humans actually go about making decisions. And they bemoan what they see as rampant abuse of the term *bounded rationality*. Bounded rationality is

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of putting a dollar value on human welfare (see, e.g., Nussbaum and Sen 1993; Sagoff 2008).

<BQ>not simply a discrepancy between human reasoning and the laws of probability or some form of optimization. [It] dispenses with the notion of optimization and, usually, with probabilities and utilities as well. It provides an alternative to current norms, not an account that accepts current norms and studies when humans deviate from these norms. Bounded rationality means rethinking the norms as well as studying the actual behavior of minds and institutions. (Selten and Gigerenzer 2001, p. 6)<BQ>

Gigerenzer is especially critical of discussions that ignore the environment in which behavior occurs, and he suggests "ecological rationality" as a better term.

In Gigerenzer's view, ecological (or bounded) rationality does not make use of computations at all; rather it employs a set of conscious or unconscious heuristics (an "adaptive toolbox") that has been honed by biological evolution as well as by individual and cultural experience. It is these heuristics that give rise to our gut feelings, intuitions, and hunches, where Gigerenzer uses "the terms *gut feeling, intuition*, or *hunch*interchangeably to refer to a judgment

1. that appears quickly in consciousness,
2. whose underlying reasons we are not fully aware of, and
3. is strong enough to act upon." (2007, p. 16)

Gigerenzer's claim is that gut feelings provide a basis for action that not only need not be less rational than computation, but that, in the appropriate environment, can sometimes even be superior.

His best example is catching a ball. Reflecting a view

that is widespread in cognitive psychology, Richard Dawkins (in *The Selfish Gene*) offered a description of the procedure a ball player uses to catch a fly ball:

> <BQ>When a man throws a ball high in the air and catches it again, he behaves as if he has solved a set of differential equations in predicting the trajectory of the ball. He may neither know nor care what a differential equation is, but this does not affect his skill with the ball. At some subconscious level, something functionally equivalent to the mathematical calculations is going on. (Dawkins 1989, p. 6)<BQ>

Because Dawkin's description is in such striking contrast with how ball players actually proceed, it provides Gigerenzer with a good point of departure. Real ball players do nothing like calculating the ball's trajectory; instead, they employ various heuristics that are simultaneously both easier and more effective. One especially effective procedure (apparently also used by dogs) is what Gigerenzer calls the "gaze heuristic" (see, e.g., Gigerenzer 2007).

The gaze heuristic is a stunningly simple rule of thumb that enables the player to be at that precise spot just when the ball lands (and hence to catch the ball), but it does not enable him or her to predict where it will land. It requires nothing more than fixing one's eye on the ball when it is high, and running in a direction that maintains a constant angle between the line of sight and the ground as it comes down. It does not require knowing its original position and velocity, Newton's laws, or even of the fact of gravity. But because humans have

evolved in a world governed by gravity, the fact of gravity is, as it were, already built into their adaptive capacities.

The gaze heuristic is only one of many of Gigerenzer's examples of adaptive thinking, but it well illustrates a central moral he wishes to draw:

> <BQ>Rationality is said to be a means toward an end. But the end is dependent on the interpretation of bounded rationality being taken. For optimization under constraints, the end is to estimate the point at which the ball will land…. Knowing the cognitive process can inform us, however, that the end might be a different one. In the case of the gaze heuristic, the player's goal is not to predict the landing point, but to be there where the ball lands. The rationality of heuristics is not simply a means to a given end; the heuristic itself can define what the end is. (2009, p. 89)<BQ>

And for that goal, the gaze heuristic is not only more practical, but it is also at least equally (and often a good deal more) reliable.[4]

<A>How Rational is the Guidance of Rational Choice Theory in the Case of Extreme Events?<A>

Assessing the costs and benefits of human health (or lives)

[4] A parallel to recent developments in computer science suggests itself: computer chips that process certain kinds of data (especially visual data) with less precision than existing chips, but with orders of magnitude greater efficiency (see, e.g., Hardesty 2010).

is an obvious challenge for rational choice theory, and it is one with which economists have long struggled. Low-probability and high-impact events occurring in the distant future pose two especially difficult challenges for cost-benefit analysis: first is the temporal disparity between when (and by whom) the costs of regulation must be paid and when and (for whom) those of non-regulation come due, and the notorious problem of "discount rates" inhering in the effort to estimate the costs of future climate change in present terms. But in the interests of time, I will jump directly to the second, perhaps even more fundamental, challenge: the difficulty (often impossibility) of computing the magnitude of possible catastrophic events, the probability of their occurrence, or their cost.

This problem is specific to catastrophic events; it is especially acute for assessing the risks of climate change. It derives, first, from the inherent (i.e., structural) uncertainty of climate science; second, from the uncertainty of behavioral responses to such changes; and finally, from the implications of all this uncertainty for cost-benefit analysis. Climate science can tell us that catastrophic climate changes are possible, even that the probability of such change is not negligible, but it cannot provide reliable estimates of just what that probability is. Indeed, the more extreme the event, the more uncertain the probability of its occurrence. The obvious question is: how, in the absence of quantitative estimates of the probabilities of extreme events on the one hand, and of magnitude of their outcomes on the other, can one estimate the expected costs they would incur? One answer is simply to limit the outcomes to be

considered to those whose likelihood is judged to exceed some minimal value.

A number of authors (e.g., Taleb 2007) have argued that conventional decision theory systematically undervalues the effects of hard-to-predict but high-impact events (popularly referred to as "black swans"). Indeed, the response of many cost-benefit analysts is to bypass this problem altogether by assuming that, as the size of an event increases, its probability decreases so rapidly that the right-hand tail of the distribution can simply be ignored. In other words, extreme events need not be even taken into consideration in estimating cost because of their low probability.

Unfortunately, however, all available indications argue that high-impact events are not distributed in this way; furthermore, the very uncertainties inherent in the dynamics of climate change (as well, of course, as those due to the incompleteness of our knowledge of these dynamics) adds to the "fatness" of the right-hand tail of their distribution, thereby raising estimates of the probability of a large catastrophe on the basis of the data we have. That probability may still be small, but it can nonetheless make a huge contribution to the costs involved. Ditto for estimating the economic impact of extreme events. The absence of prior experience, and hence of prior knowledge, requires extensive speculation about how to extrapolate beyond what is known. And small modifications in these speculations can have an enormous impact on the final computations – indeed, larger even than changes in discount rate. For this reason, Harvard economist Martin Weitzman concludes

that,

<BQ>the answers to the big policy question of what to do about climate change stand or fall to a large extent on the issue of how the high-temperature damages and tail probabilities are conceptualized and modeled. By implication, the policy advice coming out of conventional thin-tailed CBA's [cost-benefit analyses] of climate change must be treated with skepticism. (2009, p. 2)<BQ>

Weitzman goes on to suggest various ways in which conventional analyses might be modified to take proper account of the risk of extreme events. But the point I wish to emphasize is that what is normally taken as providing the basis for rational decision making (namely, cost-benefit analysis) – the standard against which human behavior is judged lacking in rationality – is itself deeply problematic. For the sorts of problems we face in this area, the tools needed to connect rational decision theory with our predicament are simply not available. And an obvious question arises: while environmental economists search for better (i.e., more rational) ways to account for the impact of extreme events, might it not be possible to identify heuristics that, however imperfect, provide a more reliable basis for future action than do the dominant modes of analysis now in use? Indeed, might even ordinary people have evolved (or developed) heuristics that can outperform standard cost-benefit analyses?

GerdGigerenzer and Klaus Fiedler (2003) seem to think that they have. For example, they suggest that Slovic's data indicating a central role of "dread" in skewing perceptions of

risk in the face of extreme hazards (1987) might be reinterpreted as evidence of "ecological rationality":

<BQ>Catastrophe avoidanceneed not be seen as a socially expensive "subjective" whim, but instead as attention to the third moment of the frequency distribution . … [T]he dread risk dimension corresponds to the skewness of the distribution…. Attention to skewness corresponds to dread risk, and the degree of skewness measures the degree of dread". Moreover, they suggest that in assessing the risk of low-probability, high-impact events, "people's attention to skewness may be perfectly reasonable. (Gigerenzer and Fiedler 2003, p. 13)<BQ>

Although the authors do not explicitly say so, a reader might conclude that in environments in which the frequency distribution of hazards is substantially skewed, "dread risk" might be seen as an appropriate, even effective, heuristic – indeed, as an example of what Slovic himself calls "affective rationality" (2002, p. 420).

<A>**From Belief to Action: Fear as a Possibly Useful Heuristic for Appropriate Behavior**<A>

Thus far my discussion has focused on the reliability of risk assessment, and the closely related question of what people believe. But there is another problem as well. Belief is only a precursor to action, and certainly not in itself sufficient to guide behavior. Indeed, the gap between belief and action is huge, and a subject of much commentary. For example, when public

confidence in the reports of climate scientists was at its peak in the US, and belief in the imminent dangers of global warming seemed to be shared by a majority of American citizens, people nonetheless expressed a widespread reluctance to make any sacrifices that could help in lessening the dangers; indeed, there seemed to be a growing gap between intellectual awareness of the problems and a willingness to enact effective precautions. Why should this be so? Psychologists have generally attributed this gap to a lack of emotional engagement with either the urgency or magnitude of the threat: people don't seem to "feel" at risk. A task force meeting in 2008-2009 found at least a partial explanation in the different ways in which affect-driven and analytic processes function. In a 2011 "Report by the American PsychologicalAssociation'sTask Force on the Interface BetweenPsychology and Global Climate Change," the authors wrote:

> <BQ>The two types of processes typically operate in parallel and interact with each other. Analytic reasoning cannot be effective unless it is guided and assisted by emotion and affect (Damasio, 1994). … Global climate change appears to be an example where a dissociation between the output of the analytic and the affective system results in less concern than is advisable, with analytic consideration suggesting to most people that global warming is a serious concern, but the affective system failing to send an early warning signal. (Swim et al. 2011, p. 23)<BQ>

And here too, the relevance of fear (or dread) has particular salience.

Emotions are rational, by this argument (see, e.g., deSousa 1980), because they enable us to act, especially under conditions where rational analysis either fails or is inconclusive. This claim bears especially on fear, an emotion sometimes responsible for the difference between life and death. According to LeDoux (1996), e.g., if you were a small animal threatened by a predator, and

<BQ>had to make a deliberate decision about what to do, you would have to consider the likelihood of each possible choice succeeding or failing and could get so bogged down in decision making that you would be eaten before you made the choice. (p. 176)<BQ>

Under such circumstances, fear would clearly seem to be a useful heuristic.

Most of us, however, remain wary of fear, and for good reason. Our experiences with the political uses of this emotion after 9/11 clearly underscored just how powerful an emotion fear is, and how unwise the choices it can lead us to make. Furthermore, as a motivating force, its effect is notoriously double-edged: while fear can spur people to action, it can also impede action. Even if a necessary ingredient for translating belief into action (as some, e.g., Bechara and Damasio (2005) have argued), it can also lead to avoidance, denial, and inaction. The issue, apparently, is one of context.

Climate scientists -- even those who are themselves alarmed -- may be especially wary of evoking fear in their readers. Indeed, there are powerful constraints inhibiting all scientists from directly seeking such engagement. Theirs is the domain of the rational, not of the emotional. Their aim is to inform, to evoke in the reader the rational response to what they, as scientists, have learned. And of all the emotions, fear is generally regarded as especially counterproductive to the forming of rational responses. Furthermore, because of our current sensitivity to the ease with which it can be politically manipulated, the "fear of fear" has now itself become a political weapon in the debates about climate change. As climate scientists know better than most, this is a weapon that climate skeptics do not hesitate to deploy. Those (like Jim Hansen) who elaborate on scenarios that cannot but be frightening are called "alarmists," "fearmongerers," and accused of creating a "climate of fear," of spreading "climate porn" and "narratives of fear." No one wants to appear guilty of such charges -- perhaps especially not climate scientists.

But if conventional decision theory has routinely undervalued the risk of catastrophic events, if conventional uses of cost-benefit analysis cannot be taken as a standard against which to judge nonexpert estimates of such risks, and if fear is identified as the central factor leading us to "overestimate" such risks, might not it be viewed (at least in this particular case) as compensating for the underestimates common to expert reasoning? That, in the face of risks before which conventional theorizing about risk manifestly fails, then fear, rather than

something to be avoided, might sometimes serve as a useful heuristic for a *more* rational response?

One reaction to the difficulty of assigning probabilities to inherently unpredictable events (such as, e.g., the "tipping point" of runaway climate change) is to give up on computations that depend on them, and instead, attempt to avoid such events in whatever ways are possible. The precautionary principle (discussed above) is one obvious form this response takes. Sunstein has done an excellent job in enumerating many of the problems with this principle,[5] at least in its crude form of "do no harm." He focuses primarily on the great variety of ways in which harm can be done, including by the very exercise of precaution. And he is right: these costs too need to be included in the calculation.

But a key flaw in Sunstein's efforts to amend the precautionary principle is that he fails to address the fundamental problem that invites its formulation: the difficulty (or impossibility) of performing such calculations. And for this, the writings of the continental philosopher Hans Jonas may

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[5] One problem that he does not discuss is that efforts to exercise precaution will, if successful, by definition appear in retrospect as having been unnecessary. That is to say, they will be particularly vulnerable to the cognitive bias that comes with hindsight: they will seem not to have been needed just because their effect was to avoid the feared catastrophe. Taleb gives the example of the recommendation that might have been made prior to 9/11, and might even have been taken seriously –namely, to impose locks on cockpit doors. That person, Taleb writes, "gets no statues in public squares, not so much as a quick mention of his contribution in his obituary. 'Joe Smith, who helped avoid the disaster of 9/11, died of complications of liver disease.'Seeing how superfluous his measure was, and how it squandered resources, the public, with great help from airline pilots, might well boot him out of office. *Voxclamantis in deserto.*He will retire depressed, with a great sense of failure"(2007, Chap. 1;http://www.nytimes.com/2007/04/22/books/chapters/0422-1st-tale.html?pagewanted=3&_r=1&ei=5070&en=bdae1078f2b4a98c&ex=1178769600, accessed 10 Oct 2009)

be more to the point. Writing over 30 years ago, Jonas was already at that early point worried about the future of the environment, and he sought to articulate an "ethics for the future" – especially, "an ethics of responsibility for distant contingencies" ([1979]1984, p. 26) where "that which is to be feared has never yet happened and has perhaps no analogies in past or present experience" ([1979]1984, p. 27).Indeed, he argued that it is precisely when scientific knowledge is insufficient for predicting the future that an "ethically required extrapolation" must take over ([1979]1984, p. 29). For Jonas, "the mere knowledge of *possibilities*" suffices for such extrapolation, i.e., for the identification of appropriate ethical principles. As he writes, "it is the content, not the certainty, of the 'then' thus offered to the imagination as possible, which can bring to light … principles of morality heretofore unknown" ([1979]1984, p. 29; italics in original).

Central to Jonas' method is what he called "the heuristic of fear." His argument is often likened to (or even conflated with) the precautionary principle, but I think this is a misreading. For Jonas, "the heuristic of fear" is more in the nature of a requisite for the moral considerations that need to underlie a precautionary principle or any other such principle. By his reasoning, we learn what it is that we value, what we are committed to preserving, only when that something is under threat. Accordingly, moral philosophy must "consult our fears prior to our wishes" in order to learn what it is we truly cherish ([1979]1984, p. 27). The particular challenge raised by distant and future threats is that appropriate fear may not be in

evidence. Despite the pervasiveness of fear as a natural (autonomic) response to present or imminent danger, future threats require an effort of reason and imagination in order to evoke the appropriate fear (i.e., the fear required to guide our responses). Our responses to dangers that are imagined and distantare in that sense less natural; they require not only reason and imagination, but also, education. Jonas writes,

> <BQ>We must educate our soul to a willingness to *let* itself be affected by the mere thought of possible … calamities to future generations …. Bringing ourselves to this emotional readiness, developing an attitude open to the stirrings of fear in the face of merely conjectural and distant forecasts concerning man's destiny [requires] a new kind of *éducationsentimentale* …. ([1979]1984, p. 28)<BQ>

<A>Conclusion<A>

Thirty years ago, the forecasts to which Jonas referred may have been "merely conjectural," but they are no longer so today. Yet no appropriate response to the measurements and predictions of contemporary climate science has been forthcoming, and indeed, the promise of such a response seems to be ever receding. A few years ago, during the hottest summer on record, the US Senate declined to even consider legislation to regulate greenhouse gas emissions. Those whose hopes had been raised by Obama's earlier promises were devastated. As the Canadian political scientist Homer-Dixon (2010) wrote in the *New York Times*, "Climate policy is gridlocked, and there's virtually no chance of a breakthrough"; three months later, the outcome of the 2010 elections lent his prediction stark affirmation.

Many factors (political, economic, sociological, psychological) contributed to this denouement, and it is not the aim of this paper to review these. Rather, I have focused on what some might consider a side issue: the ways in which the dominant discourse of decisionmaking has shaped the advice our legislators have received from the country's most respected economic analysts. Most of us might recognize that regulation is desirable, but the calculations of costs and benefits commonly employed purport to show that most regulatory proposals cannot be justified on strictly economic grounds: quite simply, they do not pass the acid test of positive net benefit. If (as I believe) economic analyses have a substantial influence on public policy, and if the assumptions on which such judgments are based can themselves not be justified, the consequences of such flaws can be dire – at the very least, sufficiently soas to warrant our attention.[6]

It goes without saying that the task of estimating the costs of climate change taxes economists with problems extending well beyond their traditional domain of expertise; it also goes without saying both that sensible decision making requires such estimates, and that economics, for all the limitations of that science, provides us with our best hope for obtaining them. But economists need help. As Jonas so presciently observed, the

[6]Indeed, the confidence with which policy analysts have accepted the application of conventional standards of economic rationality to the particular problems posed by climate change seems something of a puzzle to me, especially given the mounting criticism of these standards that we have begun to see among economists themselves, and especially in comparison with the scrutiny under which the claims of climate scientists have recently been put. Perhaps it is time to put economists to the same kind of scrutiny.

specter of such "distant threats" requires new ways of thinking -- ways of thinking that are unfamiliar to contemporary human sciences but that need to be developed precisely because they might provide us with crutches when the old ways fail us. Jonas advocates the "heuristic of fear" as one such crutch, and he may have a point. Fear is certainly a problematic guide for behavior, but there are circumstances in which its assistance may be indispensable, in which the focus on catastrophe that fear invites may point us in a "more rational" direction than does our current inclination towards denial:more rational for the simple reason that it better prepares us for actions appropriate to the threats we face.

References

Bechara A,Damasio AR(2005) The somatic marker hypothesis: a neural theory of economic decision making. Games and Economic Behavior 52:336–372

Broome J (2001)Discounting the future. In: Becker L, Becker C (eds)Encyclopedia of Ethics, 2nd edn.Routledge, New York,pp 410–13

BroomeJ(2008)The ethics of climate change. Scientific American, June:69–73. Reprinted in: Folger T, Kolbert E (eds)The best American science and nature writing 2009. Houghton Mifflin, Boston

Broome J(2010) The most important thing about climate change. In: Boston J, Bradstock A, Eng D (eds)Public policy: why ethics matters. ANU E Press, Canberra, pp 101-116

Damasio A (1994)Descartes' error. Putnam, New York

de Sousa R(1987)The rationality of emotion. MIT Press, Cambridge

Elster J(1998) Emotions and economic theory.J Econ Lit 36:46-74

Elster J(1999)Alchemies of the mind: rationality and the emotions. Cambridge University Press, Cambridge

Epstein S (1994)Integration of the cognitive and the psychodynamic unconscious.Am Psychol 49:709–724

Gigerenzer G (2007)Gut feelings: the intelligence of the unconscious.Viking Penguin, New York

Gigerenzer G(2008)Rationality for mortals.Oxford University Press, Oxford

Gigerenzer G, Fiedler K (2003) Minds in environments: the potential of an ecological approach to cognition. Accessed February 15, 2011. http://economics.uchicago.edu/download/MInds_in_Envir.pdf. Accessed 15 Feb 2011.

Gigerenzer G,Selten R(2001) Rethinking rationality. In:Gigerenzer G,Selten R (eds) Bounded Rationality: The Adaptive Toolbox. MIT Press, Cambridge, pp 1-12

Hanoch Y(2002) 'Neither an angel nor an ant': emotion as an aid to bounded rationality. J EconPsychol 23:1-25

Hardesty L (2010) The surprising usefulness of sloppy arithmetic. Masachusetts Institute of Technology, MIT News, Jan 3, 2011. http://newsoffice.mit.edu/2010/fuzzy-logic-0103

Homer-Dixon T (2010) Disaster at the top of the world. The New York Times, Aug 22. http://www.nytimes.com/2010/08/23/opinion/23homer-dixon.html

Jonas H ([1979]1984) The imperative of responsibility. University of Chicago Press, Chicago

Keller EF(2010) Climate science, truth, and democracy (unpublished manuscript)

Kluger J (2006) How Americans are living dangerously. Time, Nov.

26. http://content.time.com/time/magazine/article/0,9171,1562978,00.html. Accessed 10 Oct 2011

LeDoux JE(1996)The emotional brain. Simon and Schuster, New York

Lerner JS,Keltner D(2001) Fear, anger, and risk.JPersSocPsychol 81:146-159

Lopes LL (1992) Risk perception and the perceived public. In: Bromley DW, Segerson K (eds) The social response to environmental risk.Kluwer Academic Publishers, Boston, pp 57–73

Nelson J(2006)Economics for Humans. University of Chicago Press, Chicago

Nordhaus WD (2007) A review of the Stern Review on the economics of climate change. J Econ Lit 45:686–702

Nussbaum MC(1997) Flawed foundations: the philosophical critiqueof (a particular type of) economics. Univ Chic Law Rev 1197:1199-203

Nussbaum MC, Sen AK (eds) (1993)The quality of life. Oxford University Press, New York

Obama B (2011) Executive order 13563—improving regulation and regulatory review. The White House, Office of the Press Secretary, Jan 18. https://www.whitehouse.gov/the-press-office/2011/01/18/improving-regulation-and-regulatory-review-executive-order. Accessed 12 Sept 2012

Sagoff M(2008)The economy of the Earth: philosophy, law, and the environment, 2nd edn. Cambridge University Press, New York

Sen AK(1977) Rational fools: acritique of the behavioral foundations of economic theory. Philos Public Affairs 6:317-344

Simon HA(1955) Behavioral model of rational choice.Q J Econ 69:99-118

Simon HA(1990) Invariants of human behavior.AnnuRevPsychol41:1-19

Slovic P(1987) Perception of risk.Science 236:280-285

Slovic P, Finucane M, Peters E, MacGregor DG(2002) The affect heuristic. In: Gilovich T, Griffin D, Kahneman D (eds)Heuristics and biases: the psychology of intuitive judgment. Cambridge University Press, New York, pp 397-420

Slovic P, Peters E, Finucane M, MacGregor D (2005) Affect, risk, and decision making. Health Psychol 24:S35-S40

Stern N (2007) Findings of the Stern Review on the economics of

climatechange, Yale Symposium on the Stern Review. Yale Center for the Study of Globalization, Yale University, pp 7-39. http://www.ycsg.yale.edu/climate/forms/FullText.pdf. Accessed Feb 20 2011

Sunstein CR(2002) The paralyzing principle. Regulation25(4):32-37

Sunstein CR(2005)Laws of fear:beyond the precautionary principle. Cambridge University Press, New York

Sunstein CR (2006) The one percent doctrine. The University of Chicago Law School Faculty Blog, June 27. http://uchicagolaw.typepad.com/faculty/2006/06/the_one_percent.html. Accessed 12 Sept 2012

Swim JK, Clayton S, Doherty T, et al (2011)Psychology & global climate change: addressing a multifaceted phenomenon and set of challenges. A report of the American Psychological Association task force on the interface between psychology and global climate change.American Psychological Association.http://www.apa.org/science/about/publications/climate-change.aspx

Taleb NN(2007)The black swan:theimpact of the highly improbable. Random House, New York

Tversky A, Kahneman D(1973) Availability:aheuristic for judging frequency and probability. CognPsychol 5: 207-232

WeitzmanML (1998)Why the far-distant future should be discounted at its lowest possible rate. J Environ Econ Management36:201-208

Weitzman ML (2007) A review of the Stern Review on the economics of climate change. J Econ Lit 45:703–724

Weitzman ML (2009) On modeling and interpreting the economics of catastrophic climate change. Rev Econ Stat 91: 1–19

Wheatley C(2008) Harvard professor says U.S. administration is at fault for public's skeptical view of science.Chronicle Online. Cornell University, Sept 5.http://www.news.cornell.edu/stories/Sept08/Jasanoff.cover.cw.html. Accessed 1 February 2011

Younge G (2010) The war on terror has been about scaring people, not protecting them. The Guardian, Jan. 3. http://www.theguardian.com/global/2010/jan/03/yemen-anti-terrorism-rendition-security. Accessed 12 Sept 2012

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