Essay

Probability Neglect: Emotions, Worst Cases, and Law

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> If someone is predisposed to be worried, degrees of unlikeliness seem to provide no comfort, unless one can prove that harm is absolutely impossible, which itself is not possible.[1]
>
> [A]ffect-rich outcomes yield pronounced overweighting of small probabilities . . . .[2]
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> On Sept. 11, Americans entered a new and frightening geography, where the continents of safety and danger seemed forever shifted.
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> Is it safe to fly? Will terrorists wage germ warfare? Where is the line between reasonable precaution and panic? Jittery, uncertain and assuming the worst, many people have answered these questions by forswearing air travel, purchasing gas masks and radiation detectors, placing frantic calls to pediatricians demanding vaccinations against exotic diseases or rushing out to fill

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1. JOHN WEINGART, WASTE IS A TERRIBLE THING TO MIND 362 (2001).

2. Yuval Rottenstreich & Christopher K. Hsee, *Money, Kisses, and Electric Shocks: On the Affective Psychology of Risk*, 12 PSYCHOL. SCI. 185, 188 (2001) (finding that when emotions are triggered, variations in probability matter relatively little).

prescriptions for Cipro, an antibiotic most experts consider an unnecessary defense against anthrax.[3]

I. RISKS, NUMBERS, AND REGULATION

Consider the following problems:

- People live in a community near an abandoned hazardous waste site. The community appears to suffer from an unusually high number of deaths and illnesses. Many members of the community fear that the hazardous waste site is responsible for the problem. Administrative officials attempt to offer reassurance that the likelihood of adverse health effects, as a result of the site, is extremely low.[4] The reassurance is met with skepticism and distrust.

- An airplane, carrying people from New York to California, has recently crashed. Although the source of the problem is unknown, many people suspect terrorism. In the following weeks, many people who would otherwise fly are taking trains or staying home. Some of those same people acknowledge that the statistical risk is exceedingly small. Nonetheless, they refuse to fly, in part because they do not want to experience the anxiety that would come from flying.

- An administrative agency is deciding whether to require labels on genetically modified food. According to experts within the agency, genetically modified food, as such, poses insignificant risks to the environment and to human health. But many consumers disagree. Knowledge of genetic modification triggers strong emotions, and the labeling requirement is thought likely to have large effects on consumer choice, notwithstanding expert claims that the danger is trivial.

How should we understand human behavior in cases of this sort? My principal answer, the thesis of this Essay, is that when intense emotions are engaged, people tend to focus on the adverse outcome, not on its likelihood. That is, they are not closely attuned to the *probability* that harm will occur.

3. Erica Goode, *Rational and Irrational Fears Combine in Terrorism's Wake*, N.Y. TIMES, Oct. 2, 2001, at F1.

4. *Cf.* LOIS MARIE GIBBS, LOVE CANAL: THE STORY CONTINUES 30-66 (1998) (discussing the rising level of fear as a result of the contamination of Love Canal).

At the individual level, this phenomenon, which I shall call "probability neglect," produces serious difficulties of various sorts, including excessive worry and unjustified behavioral changes. When people neglect probability, they may also treat some risks as if they were nonexistent, even though the likelihood of harm, over a lifetime, is far from trivial. Probability neglect can produce significant problems for law and regulation. As we shall see, regulatory agencies, no less than individuals, may neglect the issue of probability, in a way that can lead to either indifference to real risks or costly expenditures for little or no gain. If agencies are falling victim to probability neglect, they might well be violating relevant law.[5]

Indeed, we shall see that the idea of probability neglect helps illuminate a number of judicial decisions, which seem implicitly attuned to that idea, and which reveal an implicit behavioral rationality in important pockets of federal administrative law. As we shall also see, an understanding of probability neglect helps show how government can heighten, or dampen, public concern about hazards. Public-spirited political actors, no less than self-interested ones, can exploit probability neglect so as to promote attention to problems that may or may not deserve public concern. It will be helpful to begin, however, with some general background on individual and social judgments about risks.

A. *Cognition*

On the conventional view of rationality, probabilities matter a great deal to reactions to risks. But emotions, as such, are not assessed independently; they are not taken to play a distinctive role.[6] Of course, people might be risk-averse or risk-inclined. For example, it is possible that people will be willing to pay $100 to eliminate a 1/1000 risk of losing $900. But analysts usually believe that variations in probability should matter, so that there would be a serious problem if people were willing to pay *both* $100 to eliminate a 1/1000 risk of losing $900 *and* $100 to eliminate a 1/100,000 risk of losing $900. Analysts do not generally ask, or care, whether risk-related dispositions are a product of emotions or something else.

5. *See, e.g.*, Indus. Union Dep't v. Am. Petroleum Inst., 448 U.S. 607, 655 (1980) (plurality opinion) (requiring OSHA to show a "significant" risk before regulating, and measuring significance by reference to probability).

6. *See, e.g.*, RICHARD A. POSNER, ECONOMIC ANALYSIS OF LAW 12-13 (5th ed. 1998). *See generally* JOHN VON NEUMANN & OSKAR MORGENSTERN, THEORY OF GAMES AND ECONOMIC BEHAVIOR (1944) (describing expected utility theory).

Of course, it is now generally agreed that in thinking about risks, people rely on certain heuristics and show identifiable biases.[7] Those who emphasize heuristics and biases are often seen as attacking the conventional view of rationality.[8] In a way they are doing just that, but the heuristics-and-biases literature has a highly cognitive focus, designed to establish how people proceed under conditions of uncertainty. The central question is this: When people do not know about the probability associated with some risk, how do they think? It is clear that when people lack statistical information, they rely on certain heuristics, or rules of thumb, which serve to simplify their inquiry.[9] Of these rules of thumb, the "availability heuristic" is probably the most important for purposes of understanding risk-related law.[10] Thus, for example, "a class whose instances are easily retrieved will appear more numerous than a class of equal frequency whose instances are less retrievable."[11] The point very much bears on private and public responses to risks, suggesting, for example, that people will be especially responsive to the dangers of AIDS, crime, earthquakes, and nuclear power plant accidents if examples of these risks are easy to recall.[12]

This is a point about how *familiarity* can affect the availability of instances. But *salience* is important as well. "The impact of seeing a house burning on the subjective probability of such accidents is probably greater than the impact of reading about a fire in the local paper."[13] So, too, recent events will have a greater impact than earlier ones. The point helps explain much risk-related behavior. For example, whether people will buy insurance for natural disasters is greatly affected by recent experiences.[14] If floods have not occurred in the immediate past, people who live on flood plains are far less likely to purchase insurance.[15] In the aftermath of an earthquake, the proportion of people carrying earthquake insurance rises sharply—but it declines steadily from that point, as vivid memories recede.[16] For purposes of law and regulation, the problem is that the availability heuristic can lead to serious errors of fact, in terms of both

7. *See generally* HEURISTICS AND BIASES: INTUITIVE JUDGMENT (Thomas Gilovich et al. eds., 2002); JUDGMENT UNDER UNCERTAINTY: HEURISTICS AND BIASES (Daniel Kahneman et al. eds., 1982).

8. *See, e.g.*, Richard A. Posner, *Rational Choice, Behavioral Economics, and the Law*, 50 STAN. L. REV. 1551, 1553 (1998).

9. *See* Christine Jolls et al., *A Behavioral Approach to Law and Economics*, 50 STAN. L. REV. 1471, 1518-19 (1998).

10. *See* Amos Tversky & Daniel Kahneman, *Judgment Under Uncertainty: Heuristics and Biases*, *in* JUDGMENT UNDER UNCERTAINTY: HEURISTICS AND BIASES, *supra* note 7, at 3, 11-14.

11. *Id.* at 11.

12. PAUL SLOVIC, THE PERCEPTION OF RISK 37-48 (2000).

13. *See* Tversky & Kahneman, *supra* note 10, at 11.

14. SLOVIC, *supra* note 12, at 14.

15. *Id.*

16. *Id.*

excessive controls on small risks that are cognitively available and insufficient controls on large risks that are not.[17]

The cognitive emphasis of the heuristics-and-biases literature can be found as well in prospect theory, a departure from expected utility theory that explains decision under risk.[18] For present purposes, what is most important is that prospect theory offers an explanation for simultaneous gambling and insurance.[19] When given the choice, most people will reject a certain gain of *X* in favor of a gamble with an expected value below *X*, *if the gamble involves a small probability of riches*. At the same time, most people prefer a certain loss of *X* to a gamble with an expected value less than *X*, *if the gamble involves a small probability of catastrophe*.[20] If expected utility theory is taken as normative, then people depart from the normative theory of rationality in giving excessive weight to low-probability outcomes when the stakes are high. Indeed, we might easily see prospect theory as emphasizing a form of probability neglect. But in making these descriptive claims, prospect theory does not specify a special role for emotions. This is not a puzzling oversight, if it counts as an oversight at all. For many purposes, what matters is what people choose, and it is unimportant to know whether their choices depend on cognition or emotion, whatever may be the difference between these two terms.

B. *Emotion*

No one doubts, however, that in many domains, people do not think much about variations in probability and that emotions have a large effect on judgment and decisionmaking.[21] Would a group of randomly selected people pay more to reduce a 1/100,000 risk of getting a gruesome form of cancer than a similar group would pay to reduce a 1/200,000 risk of getting that form of cancer? Would the former group pay twice as much? With some low-probability events, anticipated and actual emotions, triggered by the best-case or worst-case outcome, help to determine choice. Those who buy lottery tickets, for example, often fantasize about the goods associated

17. *See* Timur Kuran & Cass R. Sunstein, *Availability Cascades and Risk Regulation*, 51 STAN. L. REV. 683, 703-05 (1999); Roger G. Noll & James E. Krier, *Some Implications of Cognitive Psychology for Risk Regulation*, 19 J. LEGAL STUD. 747, 769-71 (1990).

18. *See* Daniel Kahneman & Amos Tversky, *Prospect Theory: An Analysis of Decision Under Risk*, *in* CHOICES, VALUES, AND FRAMES 17, 28-38 (Daniel Kahneman & Amos Tversky eds., 2001); Amos Tversky & Daniel Kahneman, *Advances in Prospect Theory: Cumulative Representations of Uncertainty*, *in* CHOICES, VALUES, AND FRAMES, *supra*, at 44, 64-65.

19. Kahneman & Tversky, *supra* note 18, at 14-15.

20. For a lucid discussion, with applications to litigation, see Chris Guthrie, *Framing Frivolous Litigation: A Psychological Theory*, 67 U. CHI. L. REV. 163, 164-75 (2000).

21. George F. Loewenstein et al., *Risk as Feelings*, 127 PSYCHOL. BULL. 267 (2001); Eric A. Posner, *Law and the Emotions*, 89 GEO. L.J. 1977, 1979-84 (2001).

with a lucky outcome.[22] With respect to risks of harm, many of our ordinary ways of speaking suggest strong emotions: panic, hysteria, terror. People might refuse to fly, for example, not because they are currently frightened, but because they anticipate their own anxiety, and they want to avoid it. It has been suggested that people often decide as they do because they anticipate their own regret.[23] The same is true for fear. Knowing that they will be afraid, people may refuse to travel to Israel or South Africa, even if they would much enjoy seeing those nations and even if they believe, on reflection, that their fear is not entirely rational. Recent evidence is quite specific.[24] It suggests that people greatly neglect significant differences in probability when the outcome is "affect rich"—when it involves not simply a serious loss, but one that produces strong emotions, including fear.[25]

To be sure, the distinction between cognition and emotion is complex and contested.[26] In the domain of risks, and most other places, emotional reactions are usually based on thinking; they are hardly cognition-free. When a negative emotion is associated with a certain risk—pesticides or nuclear power, for example—cognition plays a central role.[27] For purposes of the analysis here, it is not necessary to say anything especially controversial about the nature of the emotion of fear. The only suggestion is that when emotions are intense, calculation is less likely to occur, or at least

22. *See generally* PHILIP J. COOK & CHARLES T. CLOTFELTER, SELLING HOPE (1991).

23. Graham Loomes & Robert Sugden, *Regret Theory: An Alternative Theory of Rational Choice Under Uncertainty*, 92 ECON. J. 805 (1982).

24. *See* Loewenstein et al., *supra* note 21, at 276-78; Rottenstreich & Hsee, *supra* note 2, at 186-88.

25. *See* Rottenstreich & Hsee, *supra* note 2, at 186-88.

26. For varying views, see generally JON ELSTER, ALCHEMIES OF THE MIND: RATIONALITY AND THE EMOTIONS (1999) (arguing for a mostly cognitive view of the emotions, but emphasizing arousal); and MARTHA C. NUSSBAUM, UPHEAVALS OF THOUGHT: THE INTELLIGENCE OF EMOTIONS (2001) (supporting a highly cognitive view of the emotions without emphasizing arousal).

27. Much research suggests that the brain has special sectors for emotions and that some types of emotions, including some fear-type reactions, can be triggered before the more cognitive sectors become involved at all. JOSEPH LEDOUX, THE EMOTIONAL BRAIN 157-65 (1996). Those who hear sudden, unexplained noises are fearful before they are able to identify the source of the noise. R.B. Zajonc, *Feeling and Thinking: Preferences Need No Inferences*, 35 AM. PSYCHOLOGIST 151 (1980); R.B. Zajonc, *On the Primacy of Affect*, 39 AM. PSYCHOLOGIST 117 (1984). People who have been given intravenous injections of procaine, which stimulates the amygdala, report panic sensations. David Servan-Schreiber & William M. Perlstein, *Selective Limbic Activation and Its Relevance to Emotional Disorders*, 12 COGNITION & EMOTION 331 (1998). In research with human beings, electrical stimulation of the amygdala leads to reported feelings of fear and foreboding, even without any reason for these emotions, leading people to say, for example, that they feel as if someone were chasing them. Jaak Panksepp, *Mood Changes*, *in* 1 HANDBOOK OF CLINICAL NEUROLOGY 271, 276 (P.J. Vinken et al. eds., 1985). It is not true, however, that fear in human beings is generally precognitive or noncognitive, and even if it is in some cases, it is not clear that noncognitive fear would be triggered by most of the risks faced in everyday human lives. On the general idea of "dual processing," both heuristic and systematic, see DUAL-PROCESS THEORIES IN SOCIAL PSYCHOLOGY (Shelly Chaiken & Yaacov Trope eds., 1999).

that form of calculation that involves assessment of risks in terms of not only the magnitude but also the probability of the outcome.

Drawing on and expanding the relevant evidence, I will emphasize a general phenomenon here: In political and market domains, people often focus on the desirability of the outcome in question and pay (too) little attention to the probability that a good or bad outcome will, in fact, occur. It is in such cases that people fall prey to probability neglect, which is properly treated as a form of quasi-rationality.[28] Probability neglect is especially large when people focus on the worst possible case or otherwise are subject to strong emotions. When such emotions are at work, people do not give sufficient consideration to the likelihood that the worst case will actually occur. This is quasi-rational because, from the normative point of view, it is not fully rational to treat a 1% chance of *X* as equivalent, or nearly equivalent, to a 99% chance of *X*, or even a 10% chance of *X*. Because people suffer from probability neglect, and because neglecting probability is not fully rational, the phenomenon I identify raises new questions about the widespread idea that ordinary people have a kind of rival rationality superior to that of experts.[29] Most of the time, experts are concerned principally with the number of lives at stake,[30] and for that reason they will be closely attuned, as ordinary people are not, to the issue of probability.

By drawing attention to probability neglect, I do not mean to suggest that most people, most of the time, are indifferent to large variations in the probability that a risk will come to fruition. Large variations can, and often do, make a difference—but when emotions are engaged, the difference is far less than the standard theory predicts. Nor do I suggest that probability neglect is impervious to circumstances. If the costs of neglecting probability are placed "on screen," then people will be more likely to attend to the question of probability.[31] In this light it is both mildly counterintuitive and reasonable, for example, to predict that people would

28. For the term, see RICHARD H. THALER, QUASI RATIONAL ECONOMICS, at xiii (1991). There is, however, an important qualification: the difference between risk and uncertainty. *See infra* notes 198-199 and accompanying text. The basic point is that in circumstances of risk, probabilities can be assigned, whereas under circumstances of uncertainty, probabilities cannot be assigned. When people are unable to assign probabilities, they might do well to focus on the worst case, as a way of following the maximin principle.

29. *See* Clayton P. Gillette & James E. Krier, *Risk, Courts, and Agencies*, 138 U. PA. L. REV. 1027, 1061-85 (1990) (defending the idea of competing rationalities). I do not mean to deny that some of the time ordinary people care, rationally, about values that experts disregard. All I mean to suggest is that insofar as people focus on the badness of the outcome but not on its likelihood, they are thinking less clearly than experts, who tend to focus on the statistical deaths at stake.

30. *See* SLOVIC, *supra* note 12, at 113.

31. *Cf.* HOWARD MARGOLIS, DEALING WITH RISK 91-92 (1996) (emphasizing that when ordinary people differ from experts, it is often because ordinary people do not see the tradeoffs involved).

be willing to pay *less*, in terms of dollars and waiting time, to reduce low-probability risks of an airplane disaster if they are frequent travelers. An intriguing study finds exactly that effect.[32] For similar reasons, market pressures are likely to dampen the impact of probability neglect, ensuring that, say, risks of 1/10,000 are treated differently from risks of 1/1,000,000, even if individuals, in surveys, show relative insensitivity to such differences.

Acknowledging all this, I emphasize three central points. First, differences in probability will often affect behavior far less than they should or than conventional theory would predict. Second, private behavior, even when real dollars are involved,[33] can display insensitivity to the issue of probability, especially when emotions are intensely engaged. Third, and most important, the demand for legal intervention can be greatly affected by probability neglect, so that government may end up engaging in extensive regulation precisely because intense emotional reactions are making people relatively insensitive to the (low) probability that the relevant dangers will ever come to fruition.

C. *Law*

It is not at all clear how the law should respond to probability neglect. But at a minimum, the phenomenon raises serious legal issues in administrative law, at least under statutes banning agencies from acting unless they can show a "significant risk"[34] or can establish that the benefits of regulation outweigh the costs.[35] If agencies are neglecting the issue of probability (perhaps because the public is doing so as well), they may well be acting unlawfully. Indeed, the law of judicial review shows an inchoate understanding of probability neglect, treating it as a problem for which judicial invalidation is a solution.[36] The only qualification is that the relevant law remains in an embryonic state. There is much to be done, especially at the agency level, to ensure that government is alert to the probability that harm will actually occur.

32. *See* Matthew Harrington, People's Willingness To Accept Airport Security Delays in Exchange for Lesser Risk (Jan. 28, 2002) (unpublished manuscript, on file with author).

33. Consider here the expenditure of large sums of money on state lotteries, sums that result in part from vivid mental images of good outcomes; consider also the fact that some people are willing to spend significant sums to avoid risks that have a very low probability of coming to fruition.

34. *See* Indus. Union Dep't v. Am. Petroleum Inst., 448 U.S. 607 (1980) (plurality opinion) (requiring OSHA to show a significant risk before regulating toxic substances in the workplace).

35. *See, e.g.*, Corrosion Proof Fittings v. EPA, 947 F.2d 1201 (5th Cir. 1991) (striking down a regulation because the costs were disproportionate to the benefits).

36. *See infra* Section III.A.

Outside of the context of administrative law, an understanding of probability neglect will help us to make better predictions about the public "demand" for law. When a bad outcome is highly salient and triggers strong emotions, government will be asked to do something about it, even if the probability that the bad outcome will occur is low. Political participants of various stripes, focusing on the worst case, are entirely willing to exploit probability neglect. Those who encourage people to purchase lottery tickets, focusing on the best case, do the same. An understanding of probability neglect simultaneously helps show why jurors, and ordinary officials, are not likely to be moved much by a showing that before the fact, the harm was not likely to occur. For many people, what matters is that the harm did occur, not that it was unlikely to do so before the fact.

For law, many of the most difficult questions are normative in character: Should government take account of variations in the probability that harms will occur? Should government respond to intense fears that involve statistically remote risks? When people suffer from probability neglect, should law and policy do the same thing? At first glance, we might think that even if people are neglecting probability, government and law at least should not—that the tort system and administrators should pay a great deal of attention to probability in designing institutions. If government wants to insulate itself from probability neglect, it will create institutions designed to ensure that genuine risks, rather than tiny ones, receive the most concern. Such institutions will not necessarily require agencies to discuss the worst-case scenario.[37] And if government is attempting to increase public concern about a genuine danger, it should not emphasize statistics and probabilities, but should instead draw attention to the worst-case scenario.

If government is attempting to decrease public concern with a risk that has a tiny probability of coming to fruition, it may be ineffective if it emphasizes the issue of probability; indeed, it may do better if it changes the subject or stresses instead the affirmative social values associated with running the risk.[38] On the other hand, public fear, however unwarranted,

37. *See generally* Edward A. Fitzgerald, *The Rise and Fall of Worst Case Analysis*, 18 U. DAYTON L. REV. 1 (1992); Nicholas C. Yost, *Don't Gut Worst Case Analysis*, [1983] 13 Envtl. L. Rep. (Envtl. L. Inst.) 10,394.

38. Studies show that when people discuss a low-probability risk, their concern rises even if the discussion consists mostly of apparently trustworthy assurances that the likelihood of harm really is infinitesimal. *See* Ali Siddiq Alhakami & Paul Slovic, *A Psychological Study of the Inverse Relationship Between Perceived Risk and Perceived Benefit*, 14 RISK ANALYSIS 1085, 1094-95 (1994); Donald J. MacGregor et al., *Perception of Risks from Electromagnetic Fields: A Psychometric Evaluation of a Risk-Communication Approach*, 14 RISK ANALYSIS 815, 826-28 (1994). Consider the fact that President Bush, in encouraging Americans to fly in the aftermath of the 9/11 attack, emphasized not the low probability of terrorism, but his view that flying would be a patriotic act.

may be intractable, in the sense that it may be impervious to efforts at reassurance. And if public fear is intractable, it will cause serious problems, partly because fear is itself extremely unpleasant and partly because fear is likely to influence conduct, possibly producing wasteful and excessive private precautions. If so, a governmental response, via regulatory safeguards, would appear to be justified if the benefits, in terms of fear reduction, justify the costs.

II. PROBABILITY NEGLECT: THE BASIC PHENOMENON

When it comes to risk, a key question is whether people can imagine or visualize the worst-case outcome.[39] When the worst case produces intense fear, surprisingly little role is played by the stated probability that that outcome will occur.[40] An important function of strong emotions is thus to drive out quantitative judgments, including judgments about probability, by making the best case or the worst case seem highly salient.[41] But it is important to note that probability neglect can occur even when emotions are not involved. A great deal of evidence shows that whether or not emotions are involved, people are relatively insensitive to differences in probabilities, at least when the relevant probabilities are low.

A. *Insensitivity to Variations Among Low Probabilities*

Do people care about probability at all? Of course they do; a risk of 1/100,000 is significantly less troublesome than a risk of 1/1000. But many people, much of the time, show a remarkable unwillingness to attend to the question of probability. Several studies show that when people are seeking relevant information, they often do not try to learn about probability at all. One study, for example, finds that in deciding whether to purchase warranties for consumer products, people do not spontaneously point to the probability of needing repair as a reason for the purchase.[42] Another study finds that those making hypothetical, risky managerial decisions rarely ask

39. Loewenstein et al., *supra* note 21, at 275-76.

40. *See id.*; Rottenstreich & Hsee, *supra* note 2, at 186-88. The availability heuristic is obviously relevant here, interacting in interesting ways with emotions.

41. For a general argument that strong emotions can drive out other considerations, see George Loewenstein, *A Visceral Account of Addiction*, *in* SMOKING: RISK, PERCEPTION, AND POLICY 188, 189-95 (Paul Slovic ed., 2001).

42. Robin M. Hogarth & Howard Kunreuther, *Decision Making Under Ignorance: Arguing with Yourself*, 10 J. RISK & UNCERTAINTY 15 (1995).

for data on probabilities.[43] Or consider a study involving children and adolescents,[44] in which the following question was asked:

> Susan and Jennifer are arguing about whether they should wear seat belts when they ride in a car. Susan says that you should. Jennifer says you shouldn't . . . . Jennifer says that she heard of an accident where a car fell into a lake and a woman was kept from getting out in time because of wearing her seat belt . . . . What do you think about this?[45]

In answering that question, many subjects did not think about probability at all.[46] One exchange took the following form:

> A: Well, in that case I don't think you *should* wear a seat belt.
> Q (interviewer): How do you know when that's gonna happen?
> A: Like, just hope it doesn't!
> Q: So, should you or shouldn't you wear seat belts?
> A: Well, tell-you-the-truth we should wear seat belts.
> Q: How come?
> A: Just in case of an accident. You won't get hurt as much as you will if you didn't wear a seat belt.
> Q: Ok, well what about these kinds of things, when people get trapped?
> A: I don't think you should, in that case.[47]

These answers might seem odd and idiosyncratic, but we might reasonably suppose that some of the time, both children and adults focus primarily on bad scenarios, without thinking a great deal about the question of probability.

Many studies find that significant differences in low probabilities have little impact on decisions. This finding is in sharp conflict with the standard view of rationality, which suggests that people's willingness to pay for small risk reductions ought to be nearly proportional to the size of the reduction.[48] Perhaps these findings reflect people's implicit understanding that in these settings, the relevant probability is "low, but not zero," and that finer distinctions are unhelpful. (What does a risk of 1/100,000 really

43. Oswald Huber et al., *Active Information Search and Complete Information Presentation in Naturalistic Risky Decision Tasks*, 95 ACTA PSYCHOLOGICA 15, 24-25 (1997).

44. See the summary in JONATHAN BARON, THINKING AND DECIDING 246-47 (3d ed. 2001).

45. *Id*. at 246.

46. *Id*. at 247.

47. *Id*. at 246-47.

48. Phaedra Corso et al., *Valuing Mortality-Risk Reduction: Using Visual Aids To Improve the Validity of Contingent Valuation*, 23 J. RISK & UNCERTAINTY 165, 166 (2001).

mean? How different is it, for an individual, from a risk of 1/20,000 or 1/600,000?) In an especially striking study, Kunreuther and his coauthors found that mean willingness to pay insurance premiums did not vary among risks of 1/100,000, 1/1,000,000, and 1/10,000,000.[49] They also found basically the same willingness to pay for insurance premiums for risks ranging from 1/650, to 1/6300, to 1/68,000.[50]

The study just described involved a "between subjects" design; subjects considered only one risk, and the same people were not asked to consider the various risks at the same time. Low probabilities are not likely to be terribly meaningful to most people, but most educated people would know that a 1/100,000 risk is worse than 1/1,000,000 risk. When low-probability risks are seen in isolation and are not assessed together, we have an example of the problem of "evaluability."[51] For most people, most of the time, it is very difficult to evaluate a low probability, and hence isolated decisions will pick up small or no variations between people's assessments of very different risks.

But several studies have a "within subjects" design, exposing people simultaneously to risks of different probabilities, and even here, the differences in probabilities have little effect on decisions. An early study examined people's willingness to pay (WTP) to reduce various fatality risks. The central finding was that the mean WTP to reduce such risks was, for over 40% of the respondents, unaffected by a large variation in the probability of harm, even though expected utility theory would predict significant effects from such variations.[52] A later study found that for serious injuries, WTP to reduce the risk by 12/100,000 was only 20% higher than WTP to reduce the same risk by 4/100,000, even though standard theory would predict a WTP three times as high.[53] These results are not unusual. Lin and Milon attempted to elicit people's willingness to pay to reduce the risk of illness from eating oysters.[54] There was little sensitivity to variations in probability of illness.[55] Another study found little change in WTP across probability variations involving exposure to

49. Howard Kunreuther et al., *Making Low Probabilities Useful*, 23 J. RISK & UNCERTAINTY 103, 107 (2001).

50. *Id*. at 108-09.

51. *See* Christopher K. Hsee, *Attribute Evaluability: Its Implications for Joint-Separate Evaluation Reversals and Beyond*, *in* CHOICES, VALUES, AND FRAMES, *supra* note 18, at 543, 547-49.

52. M.W. Jones-Lee et al., *The Value of Safety: Results of a National Sample Survey*, 95 ECON. J. 49, 65-66 (1985).

53. Michael W. Jones-Lee et al., *Valuing the Prevention of Non-Fatal Road Injuries: Contingent Valuation vs. Standard Gambles*, 47 OXFORD ECON. PAPERS 676, 688 (1995).

54. C.-T.J. Lin & H.W. Milon, *Contingent Valuation of Health Risk Reductions for Shellfish Products*, *in* VALUING FOOD SAFETY AND NUTRITION 83 (J.A. Caswell ed., 1995).

55. *Id*.

pesticide residues on fresh produce.[56] A similar anomaly was found in a study involving hazardous wastes, where WTP actually decreased as the stated fatality risk reduction increased.[57]

There is much to say about the general insensitivity to significant variations within the category of low-probability events. It would be difficult to produce a rational explanation for this insensitivity; recall the standard suggestion that WTP for small risk reductions should be roughly proportional to the size of the reduction.[58] Why don't people think in this way? An imaginable explanation is that in the abstract, most people simply do not know how to evaluate low probabilities. A risk of 7/100,000 seems "small"; a risk of 4/100,000 also seems "small."[59] Most people would prefer a risk of 4/100,000 to a risk of 7/100,000, and I have noted that joint evaluation improves evaluability, which would otherwise be extremely difficult.[60] But even when the preference is clear, both risks seem "small," and hence it is not at all clear that a proportional increase in WTP will follow. As suggested by the findings of Kunreuther and his coauthors, it is likely that in a between-subjects design, WTP to eliminate a risk of 4/100,000 would be about the same as WTP to eliminate a risk of 7/100,000, simply because the small difference would not matter when each risk is taken in isolation.

Note also that the studies just described involve contingent valuation, not real world choices. A significant question is whether and when actual behavior, in consumer choice or political judgment, shows a general neglect of differences among low probabilities. In labor markets, for example, are risks of 4/100,000 compensated at about the same level as risks of 7/100,000? If so, this would be a serious market failure. There appears to be no clear data on the question.[61] But we might expect that risk markets will reduce the problem of neglect, if only because some number of people will appreciate the relevant differences and drive wages and prices in the appropriate direction. Consider an analogy: Most people probably do not know whether the right price for many consumer items is what it now is, or 120% or 80% of what it now is. Small price differences would not matter to

56. Young Sook Eom, *Pesticide Residue Risk and Food Safety Valuation: A Random Utility Approach*, 76 AM. J. AGRIC. ECON. 760, 769 (1994).

57. *See* V. Kerry Smith & William H. Desvousges, *An Empirical Analysis of the Economic Value of Risk Changes*, 95 J. POL. ECON. 89 (1987).

58. Corso et al., *supra* note 48, at 166.

59. Kunreuther et al., *supra* note 49, at 105.

60. *See* Hsee, *supra* note 51, at 543.

61. *But see* W. KIP VISCUSI, FATAL TRADEOFFS 51-74 (1992) (reporting a number of studies that show a wage premium for risky jobs, and that suggest, though do not prove, that differences in low probabilities will be reflected in wages). It does seem clear that automobile prices are correlated with differences in the probability of serious harm as a result of accidents, in a way that shows attention to, not neglect of, probability variations. *Id.*

most consumers, at least for expensive products, and a consumer survey might well suggest that a modest increase or decrease in price would have no effect on most people. But lower-priced products will sell more, and hence markets will pick up differences that do not matter to, or even register for, most consumers. Perhaps risk markets work in the same way.

Quite apart from the effects of markets, some imaginative studies attempt to overcome probability neglect through visual aids[62] or through providing a great deal of information about comparison scenarios located on a probability scale.[63] Without these aids, it is not so surprising that differences in low probabilities do not matter much to many people. For most of us, most of the time, the relevant differences—between, say, 1/100,000 and 1/1,000,000—are not pertinent to our decisions, and by experience we are not well equipped to take those differences into account.

B. *Safe or Unsafe? Of Thresholds and Certainty*

A form of probability neglect can also be seen in the fact that people seem to treat situations as "safe" or "unsafe," without seeing that the real question is the likelihood of harm.[64] Consider, for example, this remarkable discussion of the effects of natural disasters:

> One of the bargains men make with one another in order to maintain their sanity is to share an illusion that they are safe, even when the physical evidence in the world around them does not seem to warrant that conclusion. The survivors of a disaster, of course, are prone to overestimate the perils of their situation, if only to compensate for the fact that they underestimated those perils once before; but what is worse, far worse, is that they sometimes live in a state of almost constant apprehension because they have lost the human capacity to screen the signs of danger out of their line of vision.[65]

What is most notable about this passage is the sharp division between ordinary people, who "share an illusion that they are safe," and those subject to a natural disaster, who "sometimes live in a state of almost constant apprehension." Part of the reason for the illusion is that people

62. *See* Corso et al., *supra* note 48, at 166.

63. Kunreuther et al., *supra* note 49 at 103.

64. This tendency is noticed and criticized in the context of the Clean Air Act in MARC K. LANDY ET AL., THE ENVIRONMENTAL PROTECTION AGENCY: ASKING THE WRONG QUESTIONS 78-82 (1994).

65. KAI T. ERIKSON, EVERYTHING IN ITS PATH: DESTRUCTION OF COMMUNITY IN THE BUFFALO CREEK FLOOD 234 (1976).

tend to be unrealistically optimistic.[66] As a result, many low-level risks do not register at all. A related reason is that people tend to reduce cognitive dissonance, sometimes by treating risks as if they were insignificant, even worth ignoring.[67] When people think that they are "safe," even though they face a statistical risk, they might well be responding to emotions, seeking to avoid the anxiety that comes from an appreciation of the inevitability of risk. In part because people tend to be unrealistically optimistic,[68] many low-level risks do not register at all. At the individual level, a decision to disregard low-level risks is far from irrational, even if it is based in whole or in part on emotions; we lack the information that would permit fine-grained risk judgments, and when the probability really is low, it may be sensible to treat it as if it were zero. Of course, regulators should do better, if only because they are typically dealing with large populations, and a risk that is best ignored at the individual level, say 1/500,000, will deserve a good deal of attention if it is faced by 200 million people. And as the passage also suggests, risks can suddenly come "on screen," making people believe that where they once were "safe," they are now "unsafe." Of course, a form of probability neglect is at work when risks are placed into these two categories.

Experimental work strongly supports this conclusion. With respect to the decision whether to insure against low-probability hazards, people show bimodal responses.[69] When a risk probability is below a certain threshold, people treat the risk as essentially zero and are willing to pay little or nothing for insurance in the event of loss. But when the risk probability is above a certain level, people are willing to pay a significant amount for insurance, indeed an amount that greatly exceeds the expected value of the risk.[70] Such bimodal responses provide further support for the intuitive suggestion that some risks are simply "off-screen," whereas others, statistically not much larger, can come "on-screen" and produce behavioral changes. And indeed, one study finds that when told that the probability of being killed in an accident is only 0.00000025 per trip, ninety percent of people said that they would not wear seatbelts—a finding apparently based on a judgment that so small a probability is essentially zero.[71]

66. SHELLEY E. TAYLOR, POSITIVE ILLUSIONS 9-12 (1989).

67. *See* GEORGE AKERLOF & WILLIAM DICKENS, *The Economic Consequences of Cognitive Dissonance*, *in* AN ECONOMIC THEORIST'S BOOK OF TALES 123, 124-28 (1984).

68. *See* TAYLOR, *supra* note 65, at 9-11.

69. *See* Garg H. McClelland et al., *Insurance for Low-Probability Hazards: A Bimodal Response to Unlikely Events*, 7 J. RISK & UNCERTAINTY 95 (1993).

70. *See id*.

71. *See* BARON, *supra* note 44, at 255.

The role of thresholds is connected with an aspect of prospect theory, emphasizing the great importance of *certainty* to people's decisions.[72] People are willing to pay relatively little for a small increment in safety, but they will pay far more when the additional increment is the last one, eliminating any risk at all.[73] A change in a risk from 0.04 to 0.03 will produce far less enthusiasm than a change from 0.01 to zero. This finding, commonly described as the "certainty effect,"[74] is in line with the suggestion that people are insensitive to variations among low probabilities and instead ask, much of the time, whether they are in the domain of the "safe" or the "unsafe."

I now turn from the general neglect of differences in low probabilities to the particular role of strong emotions in crowding out close attention to the issue of probability, both low and not so low. My central claim is that when strong emotions are involved, large-scale variations in probabilities will matter surprisingly little—even when the variations unquestionably matter when emotions are not triggered. The point applies to hope as well as to fear; vivid images of good outcomes will crowd out consideration of probability too.[75] Lotteries are successful partly for this reason.[76] Consider this account:

> They didn't really know what the odds—1 in 76 million—mean. Big dreams are easier than big odds; to be precise, in the 11 p.m. drawing, there is only one possible winning combination out of 76,275,360 . . . . Clarence Robinson, a manager at Macy's, said: "One in 76 million people right? It's just a number. I'll win."[77]

But the subject here is fear rather than hope.

C. *A Simple Demonstration*

The basic point has received its clearest empirical confirmation in a striking study of people's willingness to pay to avoid electric shocks.[78] The central purpose of the study was to test the relevance of probability in "affect rich" decisions. The experiment of central importance here attempted to see whether varying the probability of harm would matter more, or less, in settings that trigger strong emotions than in settings that

72. *See* MARGOLIS, *supra* note 31, at 83-84; Kahneman & Tversky, *supra* note 18, at 17.
73. *See* MARGOLIS, *supra* note 31, at 83-84; Kahneman & Tversky, *supra* note 18, at 17.
74. *See* Kahneman & Tversky, *supra* note 18, at 17.
75. *See* Rottenstreich & Hsee, *supra* note 2, at 186-88.
76. *See* COOK & CLOTFELTER, *supra* note 22, at 71-73.
77. Ian Shapira, *Long Lines, Even Longer Odds, Looking for a Lucky Number? How About 1 in 76,275,360?*, WASH. POST, Apr. 12, 2002, at B1.
78. Rottenstreich & Hsee, *supra* note 2, at 188.

seem relatively emotion-free. In the "strong emotion" setting, participants were asked to imagine that they would participate in an experiment involving some chance of a "short, painful, but not dangerous electric shock."[79] In the relatively emotion-free setting, participants were told that the experiment entailed some chance of a $20 penalty. Participants were asked to say how much they would be willing to pay to avoid participating in the relevant experiment. Some participants were told that there was a 1% chance of receiving the bad outcome (either the $20 loss or the electric shock), others were told that the chance was 99%, and still others were told that the chance was 100%.

The central result was that variations in probability affected those facing the relatively emotion-free injury, the $20 penalty, far more than they affected people facing the more emotionally evocative outcome of an electric shock. For the cash penalty, the difference between the median payment for a 1% chance and the median payment for a 99% chance was predictably large and indeed consistent with the standard model: $1 to avoid a 1% chance, and $18 to avoid a 99% chance.[80] For the electric shock, by contrast, the difference in probability made little difference to median willingness to pay: $7 to avoid a 1% chance, and $10 to avoid a 99% chance![81] Apparently people will pay a significant amount to avoid a small probability of an affect-laden hazard, and the amount that they will pay will not vary greatly with changes in probability.

D. *A More Complex Demonstration*

To investigate the role of probability and emotions in responses to risk, I conducted an experiment asking eighty-three University of Chicago law students to describe their maximum willingness to pay to reduce levels of arsenic in drinking water.[82] The questions had a high degree of realism. They were based on actual choices confronting the Environmental Protection Agency, involving cost and benefit information within the ballpark of actual figures used by the agency itself.[83]

Participants were randomly sorted into four groups, representing the four conditions in the experiment. In the first group, people were asked to state their maximum willingness to pay to eliminate a cancer risk of

79. *Id*.
80. *Id*.
81. *Id*.
82. I am grateful to David Schkade for indispensable help with the statistical analysis of this experiment.
83. *See* Cass R. Sunstein, *The Arithmetic of Arsenic*, 90 GEO. L.J (forthcoming 2002).

1/1,000,000.[84] In the second group, people were asked to state their maximum willingness to pay to eliminate a cancer risk of 1/100,000. In the third group, people were asked the same question as in the first, but the cancer was described in vivid terms, as "very gruesome and intensely painful, as the cancer eats away at the internal organs of the body." In the fourth group, people were asked the same question as in the second, but the cancer was described in the same terms as in the third condition. In each group, participants were asked to check off their willingness to pay among the following options: $0, $25, $50, $100, $200, $400, and $800 or more. Notice that the description of the cancer, in the "highly emotional" conditions, was intended to add little information, consisting simply of a description of many cancer deaths, though admittedly some participants might well have thought that these were especially horrific deaths.

The central hypothesis was that the probability variations would matter far less in the highly emotional conditions than in the less emotional conditions. More specifically, it was predicted that differences in probability would make little or no difference in the highly emotional conditions—and that such variations would have real importance in the less emotional conditions. This prediction was meant to describe a substantial departure from expected utility theory, which predicts that an ordinary, risk-averse person should be willing to pay more than $10X$ to eliminate a risk that is ten times more likely than a risk that he is willing to pay X to eliminate.[85] It was also expected that the tenfold difference in probabilities—between 1/100,000 and 1/1,000,000—would not, in any condition, generate a tenfold difference in willingness to pay.

Here are the results in tabular form:

	Unemotional description, mean (median in parentheses)	Emotional description, mean (median in parentheses)	Overall, mean (median in parentheses)
Probability = 1/1,000,000	71.25 (25)	132.95 (100)	103.57 (50)
Probability = 1/100,000	194.44 (100)	241.30 (100)	220.73 (100)
Overall	129.61 (50)	188.33 (100)	161.45 (100)

84. Note that the phrasing of the question ensures that participants would think of the reduction of the risk to zero, rather than to some fraction of what it was before. As I have noted, people are willing to pay far more to eliminate risks than to reduce them, even if the savings are identical. *See* Kahneman & Tversky, *supra* note 18, at 20-22.

85. *See* Corso et al., *supra* note 48, at 166.

The results for the first hypothesis are not conclusive, but point in the predicted direction.[86] In the unemotional condition, increasing the probability by a factor of ten produced a 173% increase in mean WTP, from $71.25 to $194.44. In the highly emotional condition, the increase in probability produced a smaller relative increase of 81% in WTP, from $132.95 to $241.30. Thus, while increasing the probability by a factor of ten increased WTP in both emotional conditions, in terms of percentage increases, the effect was more than twice as large in the less emotional condition compared to the emotional condition. The difference between these increases is not statistically significant, but the result is nonetheless highly suggestive, especially considering its consistency with other similar findings.[87]

The second hypothesis was also supported. The increase in probability did produce a significant overall increase of 113% in mean WTP, from $103.57 to $220.73.[88] Consistent with other work on probability neglect, however, varying the probability had a relatively weak effect on WTP. The *tenfold* increase in the risk produced barely more than a doubling of mean WTP.[89] It is noteworthy that in this experiment, the relatively sophisticated participants in the study showed far more sensitivity to probability information than in the studies, described above, by Kunreuther and his coauthors;[90] but even so, the susceptibility was far less than conventional (normative) theory would predict.[91]

From this experiment, we can offer one more potentially noteworthy result. By itself, making the description of the cancer more emotional appeared to have an effect on mean WTP, raising it from $129.61 to $188.33, although the increase was not statistically significant.[92] If this result holds up in a larger sample, the dollar magnitude of the effect of a minor change in description is surprisingly large. Indeed, the effect of

86. The data were analyzed using a 2-by-2 ANOVA (Probability by Emotionality of Description) for overall means, and by using t-tests within cells.

87. Throughout the results, the medians tell a similar (and generally stronger) version of the same story as the means, although they must be interpreted with caution due to the small number of response categories. In particular, most of the medians are either 50 or 100, and these are the only two response options between 25 and 200. Consequently, there is a substantial range of underlying "true" medians that would result from unconstrained WTP responses that are consistent with the observed pattern of medians in this study. Means are less sensitive to this feature of the responses.

88. $F(1,81) = 7.6$, $p < 0.01$.

89. The medians show a similar pattern.

90. *See supra* note 49 and accompanying text.

91. *See* Corso et al., *supra* note 48, at 166.

92. $F(1,81) = 1.8$, $p = 0.19$. This relatively small effect might be a product of the fact that even the less emotional description did, after all, involve a cancer death, which is known to produce strong reactions. *See* Richard L. Revesz, *Environmental Regulation, Cost-Benefit Analysis, and the Discounting of Human Lives*, 99 COLUM. L. REV. 941, 972-73 (1999). A more pronounced effect might be expected if the death was simply described as "a death."

merely making the description of the outcome more emotional was about half as large as a tenfold increase in actual risk. My principal emphasis, however, is on the fact that when the question was designed to trigger especially strong emotions, variations in probability had little effect on WTP, far less of an effect than when the question was phrased in less emotional terms.

E. *Other Evidence*

Probability neglect, when strong emotions are involved, has been confirmed in many studies.[93] Consider, for example, experiments designed to test levels of anxiety in anticipation of a painful electric shock of varying intensity, to be administered after a "countdown period" of a stated length. In these studies, the stated intensity of the shock had a significant effect on physiological reactions. But the probability of the shock had no effect. "Evidently, the mere thought of receiving a shock is enough to arouse individuals, but the precise likelihood of being shocked has little impact on level of arousal."[94] A related study asked people to provide their maximum buying prices for risky investments, which contained different stated probabilities of losses and gains of different magnitudes.[95] Happily for the standard theory, maximum buying prices were affected by the size of losses and gains and also by probabilities. (Note that for most people, this experiment did not involve an affect-rich environment.) But—and this is the key point—reported feelings of *worry* were not much affected by probability levels.[96] In this study, then, probability did affect behavior, but it did not affect emotions. The point has independent importance: Worry is an individual loss, even if it does not influence behavior.[97] And in most of the cases dealt with here, intense emotions drive out concern about probability, and hence both behavior and worry are affected.

Several studies have attempted to compare how people respond to differences in the probability of harm with how people respond to differences in the emotions associated with certain risks.[98] These studies

93. Loewenstein et al., *supra* note 21, at 276.
94. *Id.*
95. *Id.*
96. *Id.*
97. Note a converse point: Anticipated gain is a social benefit, even if its likelihood is low. If people receive substantial benefits from anticipating winning the lottery, there is a point in favor of having lotteries, even if almost everyone loses—at least if the pain of the loss does not outweigh the pleasure of the anticipated win.
98. Peter Sandman et al., *Agency Communication, Community Outrage, and Perception of Risk: Three Simulation Experiments*, 13 RISK ANALYSIS 35 (1994); Peter Sandman et al., *Communications To Reduce Risk Underestimation and Overestimation*, 3 RISK DECISION & POL'Y 93 (1998) [hereinafter Sandman et al., *Communications*].

hypothesized that certain low-probability risks, such as those associated with nuclear waste radiation, produce outrage, whereas other low-probability risks, such as those associated with radon exposure, do not. A central finding is consistent with that stressed here: A large difference in probability had no effect in the "high outrage" condition, with people responding the same way to a risk of 1/100,000 as to a risk of 1/1,000,000.[99] More striking still: Even when the risk was *identical* in the nuclear waste (high outrage) and radon (low outrage) cases, people in the nuclear waste case reported a much greater perceived threat and a much higher intention to act to reduce that threat.[100] Indeed, "the effect of outrage was practically as large as the effect of a 4000-fold difference in risk between the high-risk and low-risk conditions."[101] Efforts to communicate the meaning of differences in risk levels, by showing comparisons to normal risk levels, reduced the effect of outrage, but even after those efforts, outrage had nearly the same effect as a 2000-fold increase in risk.[102] A great deal of information appears to be necessary to counteract the effects of strong emotions—showing that people are not impervious to such information, but that when emotions are involved, a great deal of careful work has to be done.[103]

It should not be surprising, in this light, that visualization or imagery matters a great deal to people's reactions to risks.[104] When an image of a bad outcome is easily accessible, people will become greatly concerned about a risk, holding probability constant.[105] Consider the fact that when people are asked how much they will pay for flight insurance for losses resulting from "terrorism," they will pay more than if they are asked how much they will pay for flight insurance from all causes.[106] The evident explanation for this peculiar result is that the word "terrorism" evokes vivid images of disaster, thus crowding out probability judgments. Note also that when people discuss a low-probability risk, their concern rises even if the

99. *See* Sandman et al., *Communications*, *supra* note 98, at 102.

100. *Id*. at 106.

101. *Id*.

102. *Id*.

103. *Id*. at 106-07. Consider in particular the following suggestion:

> When people are upset about a high-outrage, low-risk situation, explanations coming from the distrusted source of the trouble may not help much; merely providing risk probability data also may not help much, even if the source is trusted. But considerable reductions in threat perception and action intentions are possible when a trusted, neutral source offers a comparison to background or a chat with a risk ladder, risk comparisons, and an action standard.

Id.

104. *See* Paul Slovic et al., *Violence, Risk Assessment and Risk Communication*, 24 LAW & HUM. BEHAV. 271 (2000).

105. *See* Loewenstein et al., *supra* note 21, at 275-76.

106. *See* E.J. Johnson et al., *Framing, Probability Distortions, and Insurance Decisions*, 7 J. RISK & UNCERTAINTY 35 (1993).

discussion consists mostly of apparently trustworthy assurances that the likelihood of harm really is infinitesimal.[107] One reason is that the discussion makes it easier to visualize the risk and hence to fear it.

Note that if probability neglect is involved, this is not a point about the availability heuristic, which leads people not to neglect probability, but to *answer* the question of probability by substituting a hard question (What is the statistical risk?) with an easy question (Do salient examples readily come to mind?).[108] The point here is not that visualization makes an event seem more probable (though this is also often true), but that visualization makes the issue of probability less relevant or even irrelevant. In theory, the distinction between use of the availability heuristic and probability neglect should not be obscure. In practice, of course, it will often be hard to know whether the availability heuristic or probability neglect is driving behavior.

Emotional reactions to risk, and probability neglect, also account for "alarmist bias."[109] When presented with competing accounts of danger, people tend to move toward the more alarming account.[110] In the key study demonstrating alarmist bias, W. Kip Viscusi presented subjects with information from two parties, industry and government. Some subjects were given low-risk information from government and high-risk information from industry; other subjects were given high-risk information from government and low-risk information from industry. The basic result was that people treated "the high risk information as being more informative."[111] This pattern held regardless of whether the low-risk information came from industry or from government. Thus, people show "an irrational asymmetry."[112] If the discussion here is correct, one reason for this asymmetry is that information, whatever its content, makes people focus on the worst case. There is a lesson for policy: It might not be helpful to present people with a wide range of information, containing both more assuring and less assuring accounts.

The most sensible conclusion is that with respect to risks of injury or harm, vivid images and concrete pictures of disaster can "crowd out" other kinds of thoughts, including the crucial thought that the probability of disaster is very small.[113] "If someone is predisposed to be worried, degrees

107. *See* Alhakami & Slovic, *supra* note 38, at 1094.

108. *See* Amos Tversky & Daniel Kahneman, *Availability: A Heuristic for Judging Frequency and Probability*, 5 COGNITIVE PSYCHOL. 207, 208-10 (1973).

109. W. Kip Viscusi, *Alarmist Decisions with Divergent Risk Information*, 107 ECON. J. 1657, 1657-59 (1997).

110. *Id*. at 1659.

111. *Id*. at 1666.

112. *Id*. at 1668.

113. It would be tempting to venture an evolutionary explanation for probability neglect. While plausible, such an explanation would be highly speculative: We could imagine evolutionary explanations both for probability neglect and for intense concern with probability.

of unlikeliness seem to provide no comfort, unless one can prove that harm is absolutely impossible, which itself is not possible."[114] With respect to hope, those who operate gambling casinos and state lotteries are well aware of the underlying mechanisms. They play on people's emotions in the particular sense that they conjure up palpable pictures of victory and easy living. With respect to risks, insurance companies and environmental groups do exactly the same. The point explains "why societal concerns about hazards such as nuclear power and exposure to extremely small amounts of toxic chemicals fail to recede in response to information about the very small probabilities of the feared consequences from such hazards."[115]

F. *Probability Neglect, "Rival Rationality," and Dual Processing*

When it comes to risk, why do experts disagree with ordinary people? Many people think that the reason lies in the fact that ordinary people have a "rival rationality."[116] On this view, experts are concerned with statistics, and, above all, with the number of lives at stake.[117] By contrast, ordinary people are concerned with a range of qualitative factors that make certain risks a special cause of concern. People care, for example, about whether risks are voluntarily incurred, potentially controllable, inequitably distributed, especially dreaded, and so forth. For those who believe that ordinary people display a rival rationality, experts seem obtuse, fixated as they are on the "bottom line" numbers.[118] On this view, experts and ordinary people display "rival rationalities," and each "side must respect the insights and intelligence of the other."[119]

There is undoubtedly some truth in the idea that ordinary people consider factors that the numbers alone obscure. People do care about whether risks come with special pain and suffering[120] or whether they are inequitably distributed. If the costs of risk avoidance are especially high, government should make special efforts to reduce the relevant risk;[121] if a risk is concentrated among poor people, or members of a disadvantaged group, government should be particularly concerned. But it is most doubtful

114. *See* WEINGART, *supra* note 1, at 362.

115. *See* Paul Slovic et al., *The Affect Heuristic*, *in* INTUITIVE JUDGMENT: HEURISTICS AND BIASES (Tom Gilovich et al. eds., forthcoming 2002) (manuscript at 20, on file with author).

116. *See* SLOVIC, *supra* note 12, at 220-31.

117. *See id*. at 223.

118. *See* Gillette & Krier, *supra* note 29, at 1071-85.

119. SLOVIC, *supra* note 12, at 231.

120. *See* George Tolley et al., *State-of-the-Art Health Values*, *in* VALUING HEALTH FOR POLICY 323, 339-44 (George Tolley et al. eds., 1994).

121. *See* Cass R. Sunstein, *Bad Deaths*, 14 J. RISK & UNCERTAINTY 259, 268-71 (1997).

that the idea of rival rationality can explain all or even most of the disagreement between experts and ordinary people. Often experts are aware of the facts and ordinary people are not. And when people are far more concerned than experts about shark attacks, or nuclear power, or terrorism, probability neglect is a large part of the reason. Hence a form of irrationality,[122] not a different set of values, often helps explain the different risk judgments of experts and ordinary people.

This point is closely connected with the suggestion that an "affect heuristic" helps explain people's concern, or lack of concern, with certain risks.[123] When people have a strong negative affect toward a process or product—arsenic or nuclear power—they are not likely to think much about the question of probability, and hence they will overreact from the normative standpoint. Here there is irrationality, not a rival rationality. And when people have a strong positive affect toward a process or product—in some communities, for example, alcohol or cigarettes, or herbal cures, or organic foods—they are not likely to think of the risks, even when the probability of harm is not low. Here too there is irrationality. My suggestion, then, is that probability neglect offers a new, if partial, explanation for the division between experts and ordinary people in thinking about social hazards—one that raises fresh questions about claims of rival rationality. Of course, it is true that experts have their own biases;[124] they are often wrong. The point is not that experts are always right, but that when ordinary people disagree with experts, it is often not because of competing value judgments, but instead because ordinary people are more subject to probability neglect.

Indeed, we should see probability neglect, not as a tribute to rival rationality, but as closely connected with the idea of "dual processing," of much recent interest in psychology, including the psychology of fear and moral judgment.[125] According to dual-process theories, some cognitive

122. To be sure, it is not clear whether probability neglect is always or entirely irrational at the individual level. People often lack information, and acquiring additional information is often costly, especially when it involves arcane issues such as the probability of harm associated with certain acts and processes. Lacking information, people might focus on the worst outcome associated with various alternatives as a way of following the maximin principle. *See infra* notes 198-199 and accompanying text. But experts and governments can do a great deal better, at least when probability information is available to them.

123. *See* Slovic et al., *supra* note 115.

124. *See* SHELDON RAMPTON & JOHN STAUBER, TRUST US, WE'RE EXPERTS! (2001). Note particularly the authors' especially alarming accounts of the link between corporate funding sources and purportedly objective research outcomes. *Id*. at 217-21; *see also* SLOVIC, *supra* note 12, at 311-12 (discussing findings of affiliation bias).

125. *See* DUAL-PROCESS THEORIES IN SOCIAL PSYCHOLOGY, *supra* note 27; Daniel Kahneman & Shane Frederick, *Representativeness Revisited: Attribute Substitution in Intuitive Judgment*, *in* HEURISTICS OF INTUITIVE JUDGMENT: EXTENSIONS AND APPLICATIONS (Thomas Gilovich et al. eds., forthcoming 2002) (on file with author).

operations, involving "system 1" are rapid, associative, and intuitive, whereas others, involving "system 2," are slow, complex, and often calculative or statistical.[126] It is clear that different sectors of the brain are involved in different kinds of processing, with some strong emotional reactions, including fear, bypassing the cortex, where more complex thinking occurs.[127] In an especially interesting paper, it has been shown that certain strong and perhaps puzzling moral reactions show activity in brain sectors that are associated with emotions.[128] My suggestion here is that probability neglect, above all when intense emotions are involved, is a central example of "system 1"—of cognitive operations that are rapid, intuitive, and noncalculative. In many circumstances, rapid processing of this sort works extremely well, as, for example, when someone is confronted with a bear in the forest or a large man with a knife in a dark alley (and immediately runs away). But governments, and people making decisions under circumstances that permit deliberation, can do a great deal better.

G. *Notes on the Media and on Heterogeneity*

From what has been said thus far, it should be clear that news sources can do a great deal to trigger fear, simply by offering examples of situations in which the "worst case" has actually come to fruition. For crime, the point is well established.[129] Media coverage of highly unusual crimes makes

126. Kahneman & Frederick, *supra* note 125 (manuscript at 4).

127. DAVID MYERS, INTUITION: ITS POWERS AND PERILS 37-39 (2002).

128. *See* Joshua Greene et al., *An fMRI Investigation of Emotional Engagement in Moral Judgment*, 293 SCIENCE 2105 (2001). The authors are concerned with two well-known problems in moral philosophy. The first, called the trolley problem, asks people to suppose that a runaway trolley is headed for five people, who will be killed if the trolley continues on its current course. The question is whether you would throw a switch that would move the trolley onto another set of tracks, killing one person rather than five. Most people would throw the switch. The second, called the footbridge problem, is the same as that just given, but with one difference: The only way to save the five is to throw a stranger, now on a footbridge that spans the track, into the path of the trolley, killing that stranger but preventing the trolley from reaching the others. Most people will not kill the stranger. But what is the difference between the two cases, if there is any?

The authors do not attempt to answer the question in principle, but they find "that there are systematic variations in the engagement of emotions in moral judgment," *id*. at 2106, and that brain areas associated with emotion are far more active in contemplating the footbridge problem that in contemplating the trolley problem, *id*. Probability neglect involves facts, not values, but it is reasonable to speculate that similar findings about the brain would distinguish cases where probability neglect does not occur from those where it is especially pronounced. Though I cannot establish it here, I believe that this point, about dual-processing with respect to both facts and values, has large and thus far unexplored implications for both political and legal theory. The discussion here of probability neglect can be seen as a tentative effort to explore those general implications.

129. *See* JOEL BEST, RANDOM VIOLENCE: HOW WE TALK ABOUT NEW CRIMES AND NEW VICTIMS (1999).

people fearful of risks that they are most unlikely to face.[130] When newspapers and magazines emphasize deaths from anthrax or mad cow disease, we should expect a significant increase in public concern, not only because of the operation of the availability heuristic, but also because people will not naturally make sufficient adjustments from the standpoint of probability. In fact, there is a large warning here. If newspapers, magazines, and news programs are stressing certain harms from remote risks, people's concern is likely to be out of proportion to reality. Significant changes should therefore be expected over time.[131] Across nations, it is also easy to imagine substantial differences, in social fear, if small initial differences are magnified as a result of media influences.[132]

For purposes of understanding those influences, we should distinguish between the availability heuristic and probability neglect. When the media emphasizes particular incidents, those incidents will become cognitively available, and hence they might seem to be far more probable than they are in fact. Stories involving violent crime and natural disasters will likely trigger the availability heuristic. At the same time, an emotionally gripping incident might attract attention simply because people focus on the outcome and not its likelihood. In the real world, it will usually be difficult to distinguish the effects of the two mechanisms. If probability information is disseminated but ignored, it is, of course, less likely that the availability heuristic is at work.

It is also true that individuals and even societies differ in their susceptibility to probability neglect. Of course, countless people take probability information into account even when the context engages human emotions. Many people are able to correct their own predisposition to anxiety, in part by thinking about the low likelihood of harm. But it also seems clear that many people neglect probability information much of the time, focusing insistently on the worst case (or, for that matter, the best). The arsenic experiment, mentioned above, displays a great deal of individual heterogeneity in taking account of probability.[133] Those who are peculiarly insensitive to probability information are likely to do poorly in many domains, including economic markets; those who are unusually attentive to that information are likely to do well for just that reason. Perhaps there are demographic differences here; it is well known that some groups are less concerned about most risks than are others.[134] The

130. *Id*. at 1-7.

131. For an account of fears of criminal violence, see *id*. at 48-92.

132. For a discussion of multiple equilibria, see Kuran & Sunstein, *supra* note 17, at 743-46.

133. *See* Cass R. Sunstein, Arsenic Experiment Results (Oct. 17, 2001) (unpublished data, on file with the University of Chicago Law School); *supra* notes 82-92 and accompanying text.

134. *See* SLOVIC, *supra* note 12, at 395-402.

difference in concern may stem, in part, from the fact that some groups are less likely to neglect probability.

On the social level, institutions can make a great deal of difference in decreasing or increasing susceptibility to probability neglect. Highly responsive democratic institutions, automatically translating public fear into law, will neglect probabilities when emotions are running high. A more deliberative democracy would attempt to create institutions that have a degree of immunity from short-term public alarm.[135] Cost-benefit analysis, for example, might serve as a check on regulation that would accomplish little good, or less good than is justified by the facts.[136] The point raises the general question of the relationship between probability neglect and regulatory law.

III. PROBABILITY NEGLECT AND REGULATORY LAW

In this Part, I emphasize the possibility that probability neglect may itself violate administrative law principles, and suggest that an inchoate understanding to that effect lies behind several important decisions. I also suggest, more briefly, that an understanding of probability neglect raises some questions about requirements of risk disclosure, and that probability neglect often plays a role in the operation of the *precautionary principle*, one of the most important risk-related ideas around the world.

A. *Administrative Law*

If emotionally charged outcomes produce intense reactions even though those outcomes are highly unlikely to occur, how might our understanding of law be improved? The simplest point is that an appreciation of probability neglect bears on several issues in administrative law, involving an agency's obligation, most of the time, to show the seriousness of any risk that it seeks to regulate. When agencies are neglecting probability, there are three possible problems. First, some statutes require an agency to demonstrate that regulated risks are "significant," and risks might not qualify as significant if they are exceedingly unlikely to come to fruition.[137] Second, some statutes require agencies to establish that the benefits of

135. *See* Kuran & Sunstein, *supra* note 17, at 742-47; CASS R. SUNSTEIN, RISK AND REASON (forthcoming 2002) (manuscript on file with author).

136. *See* Matthew D. Adler & Eric A. Posner, *Rethinking Cost-Benefit Analysis*, 109 YALE L.J. 165 (1999).

137. *See, e.g.*, Indus. Union Dep't v. Am. Petroleum Inst., 448 U.S. 607, 639-45 (1980) (plurality opinion) (requiring OSHA to show a significant risk before regulating toxic substances in the workplace).

regulation justify its costs.[138] If an agency is neglecting probability, it will have great difficulty in establishing that it has struck the appropriate balance. Third, an agency's failure to explore the probability of harm might well mean that the agency has acted arbitrarily, thus violating the Administrative Procedure Act (APA).[139] As we will see, a number of cases show an incipient understanding of probability neglect, suggesting, without using the term that this form of neglect is unlawful. The problem is that the understanding remains embryonic. Agency practice and judicial review could be far more attentive to the phenomenon.

Consider, for example, the Occupational Safety and Health Act, whose provisions are understood to require the agency to regulate only significant risks.[140] Like many other agencies, the Occupational Safety and Health Administration (OSHA) is asked to decide when a probability of harm is high enough to justify regulation. In an early case, OSHA refused to undertake this inquiry at all, urging the legal sufficiency of a general finding that a substance was carcinogenic.[141] In rejecting this argument, the Supreme Court showed an inchoate awareness of the problems associated with probability neglect.[142] The Court required the agency to engage in an exercise in quantification, so as to ensure that the risk was real rather than fanciful.[143] Indeed, the Court went further. It suggested that if the probability of getting cancer were one in a billion, it would not be serious enough to justify regulation, whereas a risk of one in a thousand might well count as significant.[144] Through encouraging quantitative assessment, the Court was evidently attempting to ensure that the agency would be responding to something other than fear of the outcome alone. OSHA has built on the Court's suggestion, indicating that a risk of 1.64/1000 is significant for statutory purposes, whereas a risk of 0.6/100,000 "may be approaching a level that can be viewed as safe."[145] When the Court upheld the Council on Environmental Quality's decision not to require worst-case analysis under the National Environmental Policy Act, it can be taken to have shown an understanding of probability neglect.[146] I will discuss this

138. *See, e.g.*, 7 U.S.C. § 136a(a) (1994) (regulating pesticides); 15 U.S.C. § 2605(a) (1994) (regulating hazardous chemical substances and mixtures); 42 U.S.C. § 300g-1(b)(6) (1994) (regulating maximum permissible contaminant level of primary drinking water).

139. 5 U.S.C. § 706 (1994).

140. *See, e.g.*, Int'l Union v. OSHA, 37 F.3d 665 (D.C. Cir. 1994) (upholding an interpretation that requires regulated risks to be significant).

141. This was the government's position in *Industrial Union Department v. American Petroleum Institute*, 448 U.S. 607.

142. *Id*. at 665.

143. *Id*.

144. *Id*.

145. Occupational Exposure to Formaldehyde, 52 Fed. Reg. 46,168 (Dec. 4, 1987) (to be codified at 29 C.F.R. pts. 1910, 1926).

146. *See* Robertson v. Methow Valley Citizens Council, 490 U.S. 332 (1989).

issue in some detail below, for it is the area in which probability neglect played its most explicit role in federal environmental law.

But the law remains extremely primitive here. Beyond the statement just quoted, OSHA has failed to give much guidance about the probability that should, in its view, trigger regulatory controls. The International Commission on Radiological Protection recommends that environmental factors should not be permitted to cause an incremental cancer risk, for those exposed over a lifetime, of 3 in 1000 or more.[147] But American practice continues to be extremely variable, and there has been no effort to ensure uniformity, or indeed to ensure that the question of probability is investigated systematically or with care.[148] Under its various programs, the EPA's acceptable range varies from 1/10,000 to 1/1,000,000.[149] In its regulations governing ozone and particulates, the EPA declined to examine the issue of probability in quantitative terms, and it was in part for this reason that one court of appeals invalidated those regulations.[150]

Of course, science will sometimes leave large gaps, allowing agencies only to specify ranges of probabilities rather than precise estimates.[151] But ranges themselves can be quite helpful, at least as a way of disciplining the analysis. Indeed, that point seems to be recognized in the occasional efforts, within both courts and agencies, to establish legally sufficient probability thresholds, below which no regulation will occur. It is possible to go further. An agency's failure to address the issue of probability raises serious legal questions, at least when statutes require some form of balancing or a demonstration that regulated risks have a certain magnitude. Consider in this light the post-1975 emergence of administrative law principles permitting,[152] and even requiring,[153] agencies to exempt trivial risks from regulatory controls. If an agency has not squarely analyzed the question of probability, it may well be taken to have acted unlawfully.

The point is especially clear under statutes that require agencies to balance costs against benefits. The Toxic Substance Control Act (TSCA), for example, asks the EPA to analyze both the costs and the benefits of

147. March Sadowitz & John Graham, *A Survey of Residual Cancer Risks Permitted by Health, Safety, and Environmental Policy*, 6 RISKS 17 (1995).

148. *Id*.

149. *Id*.

150. This was part of the motivation for the ruling of the court of appeals in *American Trucking Ass'n v. EPA*, 175 F.3d 1027, 1052 (D.C. Cir. 1999) (invalidating ozone and particulates regulations in part because of absence of clarity about harms that would trigger regulation), *rev'd sub nom.* Whitman v. Am. Trucking Ass'n, 531 U.S. 457 (2001). The relevant regulations were upheld, in their essentials, in *American Trucking Ass'n v. EPA*, 283 F.3d 355 (D.C. Cir. 2002).

151. *See* Sunstein, *supra* note 83.

152. *See, e.g.*, Sierra Club v. Dep't of Transp., 753 F.2d 120 (D.C. Cir. 1985); Ala. Power Co. v. Costle, 636 F.2d 323 (D.C. Cir. 1979).

153. *See Whitman*, 531 U.S. at 522 (Breyer, J., concurring).

regulation in quantitative terms.[154] As part of that analysis, the agency will inevitably have to attend closely to the question of probability, because benefits cannot be quantified without establishing the likelihood of harm.[155] It follows that probability neglect would count as a statutory violation, simply because an agency that fails to investigate probability will be unable to produce the requisite numbers.[156] Indeed, the leading decision under TSCA invalidates what the court saw as the EPA's blunderbuss approach to asbestos, resulting in regulation in cases in which affected people faced an extremely low risk of harm.

> For example, the EPA states that its ban of asbestos pipe will save three lives over the next thirteen years, at a cost of $128-277 million ($43-76 million per life saved)[;] . . . that its ban of asbestos shingles will cost $23-34 million to save 0.32 statistical lives ($72-106 million per life saved); [and] that its ban of asbestos coatings will cost $46-181 million to save 3.33 lives ($14-54 million per life saved) . . . .[157]

The court's analysis suggests that under statutes that require cost-benefit balancing, an agency will be forbidden from neglecting the issue of probability. The major qualification, a point to which I will return, is that fear is itself a cost and might well impose high additional costs; it is possible that fear-associated costs can tip the balance. But even if so, the agency should be under an obligation to assess, rather than to ignore, the issue of probability.

Of course, probability is not all that matters. If a significant risk is required, or if costs and benefits must be balanced, the size of the affected population is important as well.[158] A risk of 1/100,000 is not so troublesome if it is faced by only 100 people (and is thus expected to produce much less than one death each year); the same risk is quite serious if it is faced by 200 million people (and is thus expected to produce 2000 deaths annually). Indeed, there is evidence that both individuals and regulators neglect the size of the affected population, no less than probability, especially when intense emotions are involved.[159] My suggestion is not that probability is all

154. 15 U.S.C. § 2605(a) (1994).

155. Corrosion Proof Fittings v. EPA, 947 F.2d 1201, 1221-23 (5th Cir. 1991) (emphasizing the need for quantification).

156. *Id*.

157. *Id*. at 1222.

158. *See* JAMES T. HAMILTON & W. KIP VISCUSI, CALCULATING RISKS: THE SPATIAL AND POLITICAL DIMENSIONS OF HAZARDOUS WASTE POLICY 91-108 (1999) (emphasizing this point in the context of a criticism of the EPA for focusing solely on the probability of harm, and neglecting the size of the exposed population, under the Superfund statute).

159. On the general neglect of the size of the affected population, see the overviews in BARON, *supra* note 44, at 500-02; and SUNSTEIN, *supra* note 135 (manuscript at ch. 2). On the

that matters, but that when probability is disregarded, there is likely to be a serious problem under many regulatory statutes, and agency action might well be arbitrary under the APA. And if the analysis here is correct, judicial review of administrative action shows an implicit objection to probability neglect, and a number of seemingly disparate holdings can be unified with the simple suggestion that an agency that neglects probability will likely be found to have acted unlawfully. Of course, it is possible that agencies will lack information that would enable them to assign probabilities with precision or confidence.

B. *Disclosure*

An understanding of probability neglect also has implications for disclosure policies in both the public and private sectors. In the past few decades, many people have been enthusiastic about the idea that producers of hazards should inform people of the underlying risks, so as to promote knowledge rather than ignorance and so as to allow for more informed choices.[160] In the world of regulatory policy, disclosure is often said to be better than either inaction or command-and-control regulation, simply because it is less intrusive and allows people to choose as they wish.[161] In the context of drugs and medical procedures, it has become familiar for patients to be informed of low-probability events, including worst-case outcomes, even if the risk of disaster is exceedingly small.

An understanding of probability neglect raises some cautionary notes about disclosure policies, at least if the risk being disclosed involves a miniscule probability of harm. The point is not simply that people may well misunderstand risk disclosures, perceiving the hazard as far greater than it is in fact.[162] The problem is that the disclosure may alarm people, causing various kinds of harms, without giving them any useful information at all. If people neglect probability, they may fix, or fixate, on the bad outcome in a way that will cause anxiety and distress, but without altering behavior or even improving understanding. Of course, there are difficult issues here about the relationship between respect for people's autonomy and concern for their welfare. On one view, disclosure of low-probability risks is justified on grounds of autonomy even if that disclosure would increase

effects of emotions in crowding out concern with numbers, see Christopher K. Hsee & Yuval Rottenstreich, Music, Panda and Muggers (unpublished manuscript, on file with author).

160. *See* MARY GRAHAM, DEMOCRACY BY DISCLOSURE (forthcoming 2002); Cass R. Sunstein, *Informational Regulation and Informational Standing:* Akins *and Beyond*, 147 U. PA. L. REV. 613 (1999).

161. *See* GRAHAM, *supra* note 160.

162. *See* W. KIP VISCUSI, PRODUCT-RISK LABELING: A FEDERAL RESPONSIBILITY 61-69 (1993) (discussing evidence that people can greatly overestimate a labeled risk).

anxiety and distress.[163] I will not investigate that view in detail here. But if people are prone to neglect probabilities, and if we really are speaking of exceedingly improbable risks, it is by no means clear that the interest in autonomy justifies disclosure of information that will not be processed properly. At a minimum, any disclosure, if it is worthwhile, should be accompanied by efforts to enable people to put the risk in context.

This point very much bears on the civic responsibilities of those who disseminate information about risk, including public officials, the media, and those interested in moving regulatory law in one or another direction. In view of probability neglect, and the operation of the availability heuristic, it is not difficult to produce large changes in public judgments by dramatically increasing fear. Sometimes these changes are entirely justified as a way of reducing a kind of complacency, or fatalism, about risks that are real and that should be reduced. But it is, to say the least, undesirable to take advantage of the psychological mechanisms used here to provoke public concern when the risks are statistically miniscule.

C. *The Precautionary Principle*

Probability neglect sheds light on the appeal and operation of the precautionary principle, which has played a significant role in environmental regulation, to the point where it has become ubiquitous.[164] Variations on the notion can be found in at least fourteen international documents.[165] The principle can be understood in many ways, but in Europe it tends to take a strong form, suggesting that it is important to build "a margin of safety into all decision making."[166] According to one definition, the precautionary principle means "that action should be taken to correct a problem as soon as there is evidence that harm may occur, not after the harm has already occurred."[167] A comparably strong version states:

163. *Cf.* JON ELSTER, SOUR GRAPES: STUDIES IN THE SUBVERSION OF RATIONALITY 125-33 (1983) (discussing the relationship between autonomy and welfare in the context of adaptive preferences).

164. *See generally* PROTECTING PUBLIC HEALTH & THE ENVIRONMENT: IMPLEMENTING THE PRECAUTIONARY PRINCIPLE (Carolyn Raffensperger & Joel Tickner eds., 1999) (discussing and defending the precautionary principle); Cass R. Sunstein, *Beyond the Precautionary Principle*, 151 U. PA. L. REV. (forthcoming Feb. 2003) (discussing and criticizing the precautionary principle).

165. *See* INDUR M. GOKLANY, THE PRECAUTIONARY PRINCIPLE: A CRITICAL APPRAISAL OF ENVIRONMENTAL RISK ASSESSMENT 3 (2001).

166. *See* BJØRN LOMBORG, THE SKEPTICAL ENVIRONMENTALIST: MEASURING THE REAL STATE OF THE WORLD 348-50 (2001).

167. The definition is from The Word Spy, *at* http://www.wordspy.com (last visited Sept. 16, 2002).

> [T]he precautionary principle mandates that when there is a risk of significant health or environmental damage to others or to future generations, and when there is scientific uncertainty as to the nature of that damage or the likelihood of the risk, then decisions should be made so as to prevent such activities from being conducted unless and until scientific evidence shows that the damage will not occur.[168]

There is an obvious difficulty with the precautionary principle: Both regulation and nonregulation will often give rise to risks; if so, the principle would seem to be paralyzing, forbidding stringent regulation, inaction, and everything in between.[169] Consider, for example, the case of genetic engineering of food. The precautionary principle might seem to call for stringent regulation of genetic engineering, on the theory that this technology contains at least some risk of causing ecological harm.[170] But such regulation would also create risks of adverse effects, simply because genetic engineering holds out a prospect of producing ecological and health benefits.[171] The precautionary principle would seem both to require and to forbid stringent regulation of genetic engineering. The same can be said for many activities and processes, such as nuclear power and nontherapeutic cloning, simply because risks are on all sides of the situation.[172]

How, then, can the precautionary principle seem to offer guidance in the real world, as it appears to do?[173] A large part of the answer lies in probability neglect—in the form of intense concern with one of the set of risks at stake, combined with an unwillingness to investigate the likelihood that the selected risk will actually come to fruition. In the case of genetic engineering, fear of the worst-case scenario, involving severe ecological damage, appears to drive reactions, even though the worst case is unlikely indeed and even though the alleged incidents are most often myths.[174] Of course, it might be possible to revise the precautionary principle in a way

168. *The Cloning of Humans and Genetic Modification: Hearing on S. 1758 Before the Senate Appropriations Comm., Subcomm. on Labor, Health & Human Servs.*, 107th Cong. (2002) (statement of Dr. Brent Blackwelder, President, Friends of the Earth), *at* http://www.foe.org/act/testimonycloning.html.

169. *See* Sunstein, *supra* note 164.

170. *See* ALAN MCHUGHEN, PANDORA'S PICNIC BASKET: THE POTENTIAL AND HAZARDS OF GENETICALLY MODIFIED FOODS 107-09 (2000).

171. *See generally* Tony Gilland, *Precaution, GM Crops and Farmland Birds*, *in* RETHINKING RISK AND THE PRECAUTIONARY PRINCIPLE 60 (Julian Morris ed., 2000) (describing the benefits of genetic engineering and the costs associated with strict regulation).

172. *See* Sunstein, *supra* note 164.

173. *See* sources cited *supra* note 164.

174. *See* MCHUGHEN, *supra* note 170, at 104-20.

that takes account of both the magnitude and the severity of risks.[175] The suggestion here is that when the precautionary principle seems to offer guidance, it is often because of the operation of probability neglect.

IV. LAW: PRESCRIPTIVE, POSITIVE, AND NORMATIVE

I now broaden the viewscreen, asking about the relationship between probability neglect and law's prescriptive, positive, and normative tasks.[176] With prescriptive analysis, we seek to find effective ways to achieve shared goals, positive analysis attempts to explain why law takes the form that it does, and normative analysis explores what law should do. I take these up in sequence.

A. *Prescriptions: Obtaining Agreed-Upon Goals*

Suppose that government is seeking to lead people to achieve goals on which there is a social consensus. Government might, for example, want to encourage people to avoid large risks and to worry less over small risks. If so, it might do well to attempt not to provide information about probabilities, but to appeal to people's emotions and to attend to the worst case. With respect to the risks on which it wants people to focus, government should use vivid images of alarming scenarios. For cigarette smoking, abuse of alcohol, reckless driving, and abuse of drugs, this is exactly what government occasionally attempts to do. It should be no surprise that some of the most effective efforts to control cigarette smoking appeal to people's emotions, by making them feel that if they smoke, they will be dupes of the tobacco companies or imposing harm on innocent third parties—and such educative efforts work especially by providing vivid images of illness or even death.[177]

Because of probability neglect, it should not be terribly difficult to trigger public fear (terrorism is effective in part for exactly that reason). But there are serious ethical issues here. Government ought to treat its citizens with respect;[178] it should not treat them as objects to be channeled in government's preferred directions. Perhaps government ought not to manipulate or to trick people by taking advantage of their limitations in

175. Jonathan Wiener, *Precaution in a Multirisk World*, *in* THE RISK ASSESSMENT OF ENVIRONMENTAL AND HUMAN HEALTH HAZARDS (Dennis D. Paustenbach ed., 2d ed. forthcoming 2002).

176. *See* Jolls et al., *supra* note 9, at 1474.

177. *See* Lisa K. Goldman & Stanton A. Glantz, *Evaluation of Antismoking Advertising Campaigns*, 279 JAMA 772 (1998).

178. *See* JOHN RAWLS, A THEORY OF JUSTICE 133 (1971) (discussing the publicity condition).

thinking about risk. A skeptic might think that the use of worst-case scenarios, or dramatic images of harm, amounts to unacceptable manipulation.

While I cannot fully resolve the issue here, the charge seems to me unwarranted. So long as the government is democratically accountable, and attempting to discourage people from running genuinely serious risks, there should be no objection in principle. Those who want people to run risks, for economic or other purposes, use similar techniques,[179] and government should probably be permitted to meet fire with fire. Democratic accountability is important because it is a check on manipulative behavior; if government is manipulating people in an objectionable way, citizens are likely to rebel. Of course, the issue is not simple. In the context of lotteries, state governments use dramatic images of "easy street" in order to lead people to spend money for tickets whose actuarial value is effectively zero, and this strategy, exploiting probability neglect in the domain of hope, does raise ethical issues.[180] My suggestion is that if government wants people not to run risks, it is likely to do well if it appeals to their emotions and ignores probability-based arguments.

There is also a striking asymmetry between increasing fear and decreasing it. If people are now alarmed about a low-probability hazard, is there anything that government can do to provide assurance and to dampen concern? This is an unanswered question. The only clear point is that government is unlikely to be successful if it simply emphasizes the low probability that the risk will occur. There appears to be no evidence that any particular strategy will succeed.[181] But the best approach may well be simple: Change the subject. We have seen that discussions of low-probability risks tend to heighten public concern, even if those discussions consist largely of reassurance. Perhaps the most effective way of reducing fear of a low-probability risk is simply to discuss something else and to let time do the rest.[182] Of course, media attention can undermine this approach.

As I have suggested, institutional safeguards might well be the best way of ensuring against the harmful consequences of probability neglect. The Office of Information and Regulatory Affairs, within the Office of Management and Budget, monitors agency action to ensure that it is

179. *See* Jon D. Hanson & Douglas A. Kysar, *The Joint Failure of Economic Theory and Legal Regulation*, *in* SMOKING: RISK, PERCEPTION, AND POLICY, *supra* note 41, at 255 (discussing tobacco companies' studies to attract youth smokers).

180. *See generally* COOK & CLOTFELTER, *supra* note 22.

181. *But see supra* note 103 (discussing how to inform people of probabilities).

182. Recall in this regard President Bush's effort, in the aftermath of the terrorist attacks of 9/11, not to emphasize that the statistical risks were low, but to treat flying as a kind of patriotic act, one that would prevent terrorists from obtaining victory.

directed against significant problems.[183] A general requirement of cost-benefit balancing should provide a check on regulations that cannot be grounded in objective fact.[184] If government wants to protect itself against the pattern of "paranoia and neglect"[185] that now characterizes regulatory policy, analytic requirements and institutional checks will provide a start.

B. *Positive Analysis: What Drives the Demand for Law?*

If probability neglect characterizes individual judgment under certain circumstances, might government and law be neglecting probability under those same circumstances? There is good reason for an affirmative answer. In the domain of risk regulation, as elsewhere, public officials are highly responsive to the public demand for law. If people insist on government protection against risk, government is likely to provide that protection. If people show unusually strong reactions to low-probability catastrophes, government is likely to act accordingly. Of course, interest groups are involved as well. When their self-interest is at stake, we should expect them to exploit people's emotions, in particular by stressing the worst case.

1. *The Debate over "Worst-Case Analysis"*

In the environmental area, there has been an intense debate about whether the National Environmental Policy Act (NEPA) requires agencies to discuss the worst-case scenario in environmental impact statements.[186] Environmental groups have sought to ensure discussion of that scenario.[187] They have done so in part to stimulate public concern, with the knowledge that the worst case might well have a great deal of salience, even if it is highly unlikely. Consider, for example, the controversy over the possible effects of a development plan on the mule deer herd in Okanogan County, Washington.[188] In the worst case, the plan would have devastating effects on the herd. And under the pre-1986 regulations of the Council on Environmental Quality, agencies were required to include "a worst case

183. For an overview, see Office of Mgmt. & Budget, *at* http://www.whitehouse.gov/omb/inforeg/regpol.html (last visited May 24, 2002).

184. *See* Kuran & Sunstein, *supra* note 17, at 753.

185. John D. Graham, *Making Sense of Risk: An Agenda for Congress*, *in* RISKS, COSTS, AND LIVES SAVED 183, 183 (Robert W. Hahn ed., 1996).

186. *See* Robertson v. Methow Valley Citizens Council, 490 U.S. 332, 354-56 (1989); ROBERT PERCIVAL ET AL., ENVIRONMENTAL REGULATION 903-04 (3d ed. 2000).

187. *See* Fitzgerald, *supra* note 37.

188. *Robertson*, 490 U.S. at 354-56.

analysis and an indication of the probability or improbability of its occurrence."[189]

In the Reagan Administration, however, this requirement was deleted, and in the face of uncertainty, agencies were asked not to explore the worst case, but to investigate only those low-probability adverse effects that were justified by real evidence as opposed to conjecture.[190] In the context of risks facing the mule deer herd, the Forest Service refused to explore the worst case, focusing instead on a relatively narrow set of possible bad outcomes.[191] It should be easy to see how the refusal to explore the worst case has broad implications. It would suggest, for example, that an agency need not investigate the possibility of catastrophic oil spills in the event that a wildlife estuary is opened to supertankers,[192] and that the Department of the Interior, if authorized to promote oil drilling in the Alaska National Wildlife Refuge, need not explore the worst case of disastrous effects on local wildlife and wilderness values.[193]

If the account here is correct, the environmental groups were entirely rational in arguing on behalf of worst-case analysis,[194] simply because that form of analysis would trigger public attention and help promote their political goals. Indeed, probability neglect would lead people to give the worst case a high degree of salience, more in fact than it deserves. This effect is not necessarily to be deplored; if environmental problems deserve serious attention, and otherwise would not receive it, analysis of the worst case might well be a way of eliminating public torpor. For its part, the government's abandonment of the requirement of worst-case analysis could be understood as a response to a belief that people are too likely to overreact. In this light, the Reagan-era shift was a fully rational approach to quasi-rationality, meant to protect against the kinds of distortions that can come from probability neglect. The current approach, upheld by a Supreme Court that was evidently alert to the problem,[195] requires consideration of low-probability events, but only if they are not entirely remote and speculative. And although the NEPA issue has been resolved, worst-case analysis continues to be an issue in other areas,[196] and such analysis plays a large role in popular discussions of risks.[197]

189. 40 C.F.R. § 1502.22 (2001).

190. *See id.*; *see also* National Environmental Policy Act Regulations, 50 Fed. Reg. 32,234 (Aug. 9, 1985) (to be codified at 40 C.F.R. pt. 1502).

191. Methow Valley Citizens Council v. Reg'l Forester, 833 F.2d 810, 817 (9th Cir. 1987).

192. *See* Sierra Club v. Sigler, 695 F.2d 957, 968-75 (5th Cir. 1983).

193. *See* PERCIVAL ET AL., *supra* note 186 at 62-63 (3d ed. 2001).

194. *See* Robertson v. Methow Valley Citizens Council, 490 U.S. 332, 354-56 (1989).

195. *Id*.

196. *See, e.g.*, Custer County Action Ass'n v. Garvey, 256 F.3d 1024, 1037 (10th Cir. 2001).

197. Hardworking or skeptical readers are invited to engage in their own search on LEXIS/NEXIS, in any recent period, to confirm the point.

There is an important wrinkle here. While probability neglect makes worst-case analysis easy to criticize—on the ground that it triggers excessive public alarm—it might also be defended when regulators are operating under conditions of uncertainty rather than risk.[198] Under conditions of uncertainty, probabilities cannot be assigned at all, and in such cases it is reasonable to follow the maximin principle (choose the option that has the least-bad worst outcome).[199] If we are dealing with uncertainty rather than risk, worst-case analysis makes sense on these standard grounds, simply because it identifies the approach that should be disfavored by those applying the maximin principle.

2. *The Demand for Law*

A good deal of legislation and regulation can be explained partly by reference to probability neglect when emotions are running high. In this space, I cannot demonstrate the point rigorously, especially because many mechanisms contribute to regulatory responses. I have indicated that it is difficult to know, in particular cases, whether the availability heuristic is leading to an inflated judgment of probability, or whether probability is instead being neglected. I have also noted that interest groups often exploit heuristics and biases, not excluding probability neglect, and hence public-choice accounts are compatible with accounts that emphasize probability neglect. But consider a few examples:[200]

- In the aftermath of the adverse health effects allegedly caused by abandoned hazardous waste in Love Canal, the government responded with an aggressive program for cleaning up abandoned hazardous waste sites, without examining the probability that illness would actually occur. In fact, little was accomplished by early efforts to assure people of the low probability of harm.[201] When the local health department publicized controlled studies showing little evidence of adverse effects, the publicity did not dampen concern, because the numbers "had no meaning."[202] In fact, the numbers seemed to

198. *See* FRANK H. KNIGHT, RISK, UNCERTAINTY AND PROFIT (1933); Paul Davidson, *Is Probability Theory Relevant for Uncertainty? A Post-Keynesian Perspective*, 13 J. POST-KEYNESIAN ECON. 129 (1991).

199. *See* JON ELSTER, EXPLAINING TECHNICAL CHANGE 185-207 (1983).

200. *See generally* AARON WILDAVSKY, BUT IS IT TRUE? (1997) (offering many illustrations of inadequately founded health and safety scares, many of which might be analyzed in the terms used here).

201. *See* Kuran & Sunstein, *supra* note 17, at 691-98 (discussing the growth of fear of health risks at Love Canal).

202. GIBBS, *supra* note 4, at 25.

aggravate fear: "One woman, divorced and with three sick children, looked at the piece of paper with numbers and started crying hysterically: 'No wonder my children are sick. Am I going to die? What's going to happen to my children?'"[203] Questions of this sort contributed to the enactment of new legislation to control abandoned hazardous waste sites, legislation that did not embody careful consideration of the probability of significant health or environmental benefits.[204] Even now, the government does not take much account of the probability of significant harm in making clean-up decisions.[205]

- During a highly publicized campaign designed to show a connection between Alar, a pesticide, and cancer in children, the public demand for action was not much affected by the EPA's cautionary notes about the low probability of getting cancer as a result of Alar.[206]

- In the summer of 2001, vivid images of shark attacks created a public outcry about new risks for ocean swimmers.[207] Consider the fact that a NEXIS search found 940 references to shark attacks between August 4, 2001, and September 4, 2001,[208] with 130 references to "the summer of the shark."[209] This was so notwithstanding the exceedingly low probability of a shark attack and the absence of any reliable evidence of an increase

203. *Id*.

204. *See* HAMILTON & VISCUSI, *supra* note 158; Kuran & Sunstein, *supra* note 17, at 697.

205. *See* HAMILTON & VISCUSI, *supra* note 158, at 91-108 (discussing the lack of government interest in the size of the population affected).

206. *See* PERCIVAL ET AL., *supra* note 186, at 436.

207. One journalist described the recent hue and cry over shark attacks in the following terms:

> A maritime expert said on last night's "NBC Nightly News" that more people die from bees, wasps, snakes or alligators than from shark attacks. But there's no ratings in bees. Unpleasant little critters, but not scary-looking enough. With "Jaws" music practically playing in the background, the media have turned this into the Summer of the Shark. Never mind that the number of attacks has actually dropped since last year. They're here, they're nasty and they could be coming to a beach near you.

Howard Kurtz, *Shark Attacks Spark Increased Coverage*, WASH. POST, Sept. 5, 2001, *at* http://www.washingtonpost.com/wp-dyn/articles/A44720-2001Sep5.html.

208. Results of a NEXIS News search, Sept. 4, 2001. In fact, *Time* offered a widely discussed cover story on sharks and shark attacks under a screaming cover entitled, "Summer of the Shark." *See* Terry McCarthy, *Why Can't We Be Friends?: A Horrific Attack Raises Old Fears, but New Research Reveals Surprising Keys to Shark Behavior*, TIME, July 30, 2001, at 34. The story itself suggested that the probability of being attacked by a shark is about 1/30 the probability of being struck by lightning. *Id*.

209. Results of a NEXIS News search, Sept. 4, 2001.

in shark attacks in the summer of 2001.[210] Predictably, there was considerable discussion of new regulations to control the problem[211] and eventually regulations were adopted. Public fear seemed relatively impervious to the fact that the underlying risk was miniscule.

- Terrorist incidents create a severe risk of probability neglect. Consider, for example, the anthrax scare of October 2001, which was based on exceedingly few incidents. Only four people died of the infection; only about a dozen others fell ill. The probability of being infected was exceedingly low. Nonetheless, fear proliferated, with people focusing their attention on the outcome rather than the low probability of the harm. The government responded accordingly, investing massive resources in insuring against anthrax infections. Private institutions reacted the same way, asking people to take extraordinary care in opening the mail even though the statistical risks were insignificant. To say this is not to suggest that extensive precautions were unjustified in this case. Private and public institutions faced an unknown probability of a major health problem, and it was appropriate to respond. Perhaps this was a situation of uncertainty rather than of risk.[212] My point is that public fear was disproportionate to its cause and that the level of response was disproportionate too. The same might well be said of public fears about airplane safety in the aftermath of the attacks of September 11, 2001, fears that greatly outran the actual probability of disaster[213] and that led to extraordinary costs.

210. For data on shark attacks, see Florida Museum of Natural History, The International Shark Attack File, *at* http://www.flmnh.ufl.edu/fish/Sharks/ISAF/ISAF.htm (last visited May 24, 2002). The site offers comparative risk data showing, for example, that while there were 18 shark injuries and deaths in the United States in 1996, there were over 10,000 injuries and deaths from buckets and pails, over 1,500 injuries and deaths from toilet bowl products, and over 198,000 injuries and deaths from nails, tacks, screws, and bolts. *Id*.

211. *See* Maya Bell, *Divers Defend Courting the Fish So Many Fear: A Wave of Recent Shark Attacks Has Brought South Florida Shark-Feeding Groups Under State Scrutiny*, ORLANDO SENTINEL, Aug. 29, 2001, at A1.

212. *See supra* note 199 and accompanying text.

213. *See* Michael L. Rothschild, Terrorism and You—The Real Odds (Nov. 2000), *at* http://www.aei.brookings.org/publications/policy/policy_01_31.asp.

3. *Jury Behavior*

In tort cases, jury behavior is not likely to be affected greatly by assurance that the risk was unlikely to come to fruition, even if the issue of probability is legally relevant.[214] In cases involving low-probability risks of emotionally gripping harms, it should be relatively easy to convince jurors to produce high damage awards. Consider, for example, the finding that juries punish corporations that have engaged in careful cost-benefit analysis, in part by giving higher punitive damage awards when a high value has been assigned to human life.[215] This finding raises many puzzles, but it is reasonable to think that juries focus on the bad outcome and do not think much about the low, ex ante, probability that it would occur. Indeed, the probability of detection and compensation has been shown to matter little to jurors, who assess punitive awards on the basis of their outrage at the outcome and do not think about whether the harm was likely to be compensated.[216]

It follows that litigators would do well to try to engage jurors' emotions by pointing to the worst case or the bad outcome that actually occurred. There is a strong implication here for the law of negligence: Even if the law asks the jury to balance the benefits of the defendant's action against the costs, the jury is likely to disregard the issue of probability if its attention is focused on an outcome that triggers strong emotions.

C. *Normative Issues*

For law, the hardest questions might well be normative ones. It seems clear that if the public wrongly believes something to be "safe," and is treating statistically small risks as if they were zero, government should nonetheless take protective steps. By hypothesis, people are really at risk, even if some combination of cognition and emotion is leading them to neglect the danger. There is a further point. Since the focus of government is population-wide, it should attend to risks that are large in the aggregate but small for each individual (whether or not it is rational for individuals to disregard those risks).

But how should law and government respond to a quasi-rational public panic, based on an intense emotional reaction to a low-probability risk? Let

214. *See* PHANTOM RISK: SCIENTIFIC INFERENCE AND THE LAW 427-28 (Kenneth R. Foster et al. eds., 1993).

215. W. Kip Viscusi, *Corporate Risk Analysis: A Reckless Act?*, 52 STAN. L. REV. 547, 556-58 (2000).

216. *See* CASS R. SUNSTEIN ET AL., PUNITIVE DAMAGES: HOW JURIES DECIDE 132-41 (2002).

us distinguish two possible positions. The *technocrat* would want to ignore public irrationality and to respond to risks if, and to the extent that, they are real. The *populist* would want to respond to public concerns simply because they are public concerns. In my view, both positions are far too simple. Let us begin with the issue of institutional design.

1. *Institutions and Delegation*

Suppose that we agree that in some cases, government should not fall victim to probability neglect, and that it would be foolish, as a general rule,[217] to spend a large amount of taxpayer resources to reduce risks that will almost certainly never come to fruition. If so, a democratic society faces an obvious problem, for elected officers ordinarily face strong incentives to respond to excessive fear, perhaps by enacting legislation that cannot be justified by any kind of rational accounting. The point suggests the importance of ensuring a large role for specialists in the regulatory process, with the task of engaging in a kind of "peer review" of legislative proposals.[218] An understanding of probability neglect thus complements an emphasis on the risk of "availability bias," through which priorities become distorted as a result of the use of the availability heuristic.[219]

It is possible to go further. If the public demand for regulation is likely to be distorted by probability neglect, there are real advantages to a situation in which the national legislature delegates policymaking authority to people within the executive branch, at least if those people are in a better position to judge whether risks are real.[220] The Office of Information and Regulatory Affairs, in the Office of Management and Budget, attempts to assess both the costs and benefits of regulation, in a way that leads to efforts both to prompt regulations where the potential benefits are large and to discourage regulations where the potential benefits seem dwarfed by the costs.[221] Whatever might be said about cost-benefit analysis, it seems highly desirable for institutions to ensure that expensive regulations are directed to serious rather than to fanciful problems. Of course, specialists might be wrong, and even if they are right on the facts, a democratic society will override their judgments if its values justify such an override. But if highly

217. In cases that involve large-scale catastrophe, the expenditure might be worthwhile; consider protection against biological terrorism or attacks on nuclear power plants.

218. *Cf.* STEPHEN BREYER, BREAKING THE VICIOUS CIRCLE (1993) (arguing on behalf of a greater role for technocrats to ensure sensible priority-setting).

219. *See* Kuran & Sunstein, *supra* note 17, at 752-54; Noll & Krier, *supra* note 17, at 769-71.

220. For a general treatment, see DAVID EPSTEIN & SHARYN O'HALLORAN, DELEGATING POWERS (1999).

221. *See generally* Office of Info. & Regulatory Affairs, *at* http://www.whitehouse.gov/omb/inforeg/regpol.html (last visited May 24, 2002).

representative institutions, responding to public fear, are susceptible to error, then it is entirely appropriate to create institutions that will have a degree of insulation. Democratic governments should respond to people's reflective values, not to their blunders. But this claim raises some complexities of its own.

2. *Capitulating to Fear?*

Suppose that people are greatly concerned about a risk that has a small or even miniscule probability of occurring—shark attacks, or anthrax in the mail, or terrorism on airplanes. If government is confident that it knows the facts, and if people are far more concerned than the facts warrant, should the government respond, via regulation, to their concerns? Or should it ignore them, on the ground that the concerns are irrational?

Consider the individual analogy first. Even if a person's fear is irrational, it might well be rational for him to take account of that fear in his behavior. If I am afraid to fly, I might decline to do so, on the ground that my fear will make the experience quite dreadful (not only while flying but also in anticipating it). At the same time, the fear itself might be irrational, and I might even recognize that fact. If the fear exists, but if I cannot eliminate it, the most rational decision might be not to fly.

So too at the social level. Suppose, for example, that people are afraid of arsenic in drinking water and that they demand steps to provide assurance that arsenic levels will not be hazardous. Suppose too that the risks from existing levels of arsenic are infinitesimal. Is it so clear that government should refuse to do what people want it to do? The fear is, by hypothesis, real. If people are scared that their drinking water is "not safe," they are, simply for that reason, experiencing a significant loss. In many domains, widespread fear helps produce an array of additional problems. It may, for example, make people reluctant to engage in certain activities, such as flying on airplanes or eating certain foods. The resulting costs can be extremely high.[222] Why shouldn't government attempt to reduce fear, just as it attempts to produce other gains to people's well-being?

Compare the issue of hope in this regard. State governments encourage people to purchase lottery tickets, and in doing so they call people's attention to the best-case outcome, with vivid images of the great riches that are available to the victors. The analysis here suggests that governments are taking advantage of probability neglect to manipulate people into paying

222. The mad cow disease scare is an example, producing several billions of dollars in losses. Econ. Research Serv., USDA, *Dissecting the Challenges of Mad Cow and Foot-and-Mouth Disease*, AGRIC. OUTLOOK, Aug. 2000, *at* http://www.ers.usda.gov/publications/AgOutlook/aug2001/AO283c.pdf.

what is, in effect, a regressive tax. But it would be possible to respond that hope is itself a subjective good, and that those who buy lottery tickets, with the best case firmly in view, are able to enjoy life more than they would if they simply calculated the discounted value of the tickets. Certainly lottery tickets give people far more than they would get by paying the same amount in taxes. If this argument is plausible, because hope is an independent good to be encouraged even if it is quasi-rational, then perhaps fear too should be reduced, because it is an independent bad even if it is quasi-rational.

The simplest answer here is that if government is able to inform and educate people, it should do that instead. It should not waste resources on steps that will do nothing other than reduce fear. But the simplest answer is too pat. Whether information and education will work is an empirical question on which we lack definitive evidence. If these do not work, government should respond, just as individuals do, to fears that are quasi-rational but real and, by hypothesis, difficult to eradicate. Suppose, for example, that government could cheaply undertake a procedure that would reduce a tiny risk to zero—and equally important, be seen to reduce the relevant risk to zero. It seems clear that government should take this step, which may be more effective and less expensive than education and information. Recall that fear is a real social cost, and it is likely to lead to other social costs.[223] If, for example, people are afraid to fly, the economy will suffer in multiple ways; so, too, if people are afraid to send or to receive mail. The reduction of even baseless fear is a social good, not least because of the potentially enormous "ripple effects" associated with it.[224]

At the same time, there are some practical complications. If government attempts to reduce fear by regulating the activity that produces it, it might well intensify that very fear, simply by suggesting that the activity is worth regulating. As an analogue, consider the debate over whether the government should require genetically modified food to be labeled as such.[225] Mandatory labels might be criticized on the ground that they suggest a danger that does not in fact exist. Sometimes the fear that

223. My point here is not that all subjective perceptions and losses should be counted in law. Many people, for example, like to discriminate on the basis of race and sex, and they suffer a genuine loss, for which they might be willing to pay, as a result of the legal prohibition on discrimination. I do not believe that their loss should be counted, though I will not defend the point here. For a useful discussion, see Matthew D. Adler & Eric A. Posner, *Implementing Cost-Benefit Analysis When Preferences Are Distorted*, *in* COST-BENEFIT ANALYSIS 269 (Matthew D. Adler & Eric A. Posner eds., 2001). Although the fear discussed in this Essay is not fully rational, it cannot be said to be invidious or vicious, and hence cannot be "impeached" in the same way as discriminatory preferences.

224. See the discussion in Cass R. Sunstein, *The Laws of Fear*, 115 HARV. L. REV. 1119, 1130-37 (2002) (book review).

225. *See* MCHUGHEN, *supra* note 170, at 201-29.

accompanies probability neglect diminishes over time, as experience moves the activity or process from the cognitive category of "unsafe" to "safe."[226] A regulatory approach might prevent this process (salutary when the risk really is low) from occurring. If so, inaction would be the preferred course.

Even if it is clear that government should respond, many questions remain. How and how much should government respond? The answer must depend in large part on the extent of the fear and the cost of the response. If people are extremely fearful, a substantial response is of course easier to justify; if the cost of response is very high, a refusal to respond might well make sense.[227] With this point, the analysis of appropriate action becomes similar to the analysis in many other settings. We need to know how much good, and how much harm, would be done by the action in question.

A special difficulty here consists in the problem of quantifying and monetizing fear and its consequences, a problem that has yet to be seriously engaged in the relevant literature.[228] Without having any information on that question, the intensity of public concern might be a helpful proxy. As a presumption, there should be no governmental response to fear that is ungrounded in reality. But if the fear has resulted in a strong movement for political response, we have good reason to think that the fear needs to be addressed. Here, as elsewhere, information is the best response. But if it proves ineffective, low-cost interventions, designed to eliminate the fear, seem to be justified.

V. CONCLUSION

In this Essay, my central claim has been that the probability of harm is often neglected when people's emotions are activated, especially if people are thinking about the worst-case scenario. If that scenario is vivid and easy to visualize, large-scale changes in thought and behavior are to be expected.

226. See the treatment of dichotomous approaches to risk in MARGOLIS, *supra* note 31, at 82-83. As I have suggested, the belief that processes and activities are either safe or unsafe is itself a form of probability neglect.

227. Note that if the government is regulating in order to diminish public fear, it might well produce an odd form of redistribution, helping those who are irrationally fearful and hurting those who are not. Recall that there are significant variations in people's susceptibility to probability neglect; some people are far less susceptible than others. In these circumstances, a costly intervention will provide no benefits to those who are not fearful and will assist only those who are (by hypothesis senselessly) afraid. But this form of redistribution should not be troublesome if it would not create unfortunate dynamic incentives to fall victim to probability neglect, and it would be odd if redistributive regulation of this kind actually created such incentives. It is not unreasonable to speculate that less-educated people are more prone to probability neglect than more-educated people, and since education is correlated with wealth, the redistribution being discussed here would tend to give disproportionate help to the poor.

228. For a good overview of that literature, see W. KIP VISCUSI, RATIONAL RISK POLICY (2000).

The general phenomenon helps to explain public overreaction to highly publicized, low-probability risks, including those posed by abandoned hazardous waste dumps, nuclear waste disposal, and anthrax. Because rational people focus on the probability as well as the severity of harm, probability neglect is a form of quasi-rationality.[229] I have also suggested that people try to avoid cognitive dissonance, sometimes by thinking that they are "safe" and by treating a low-level risk as if it were zero. This too is a form of probability neglect, one that can lead people to subject themselves to risks that, over time, have significant cumulative effects. The problem can be still more serious for governments, which deal with large populations and which should therefore address risks that are statistically small at the individual level.

It follows that if a private or public actor is seeking to produce public attention to a neglected risk, it is best to provide vivid, even visual, images of the worst that might happen. It also follows that government regulation, affected as it is by the public demand for law, may well neglect probability too. If so, there are likely to be serious legal questions. An agency that neglects probability may be unable to establish a significant risk; such an agency will certainly have difficulty in demonstrating that the benefits of regulation outweigh its costs. If a statute requires an agency to establish that regulation is "requisite to protect the public health" or welfare,[230] that agency might be required to investigate the issue of probability to establish that regulation is indeed "requisite."[231] An understanding of probability neglect therefore illuminates some embryonic developments in administrative law;[232] it might also pave the way toward more definitive developments in the future.

There are larger normative issues in the background. If the public is neglecting a real risk, and wrongly believing itself to be "safe," surely government should respond. At first glance, however, the government should not respond if the public is demanding attention to a statistically miniscule risk, and doing so simply because people are visualizing the worst that can happen. The best response is information and education. But public fear is itself an independent concern, and it can represent a high cost in itself and lead to serious associated costs. If public fear cannot be

229. Note that to the extent that people lack information about probabilities and are in a situation of uncertainty rather than of risk, probability neglect seems defensible as a response to limited information. *See supra* notes 198-199 and accompanying text.

230. 42 U.S.C. § 7409(b)(1)-(2) (1994).

231. *See* Whitman v. Am. Trucking Ass'n, 531 U.S. 457, 494-95 (2001) (Breyer, J., concurring).

232. *See, e.g.*, Indus. Union Dep't v. Am. Petroleum Inst., 448 U.S. 607 (1980) (plurality opinion) (requiring OSHA to show a significant risk before regulating toxic substances in the workplace); Chlorine Chemistry Council v. EPA, 206 F.3d 1286 (D.C. Cir. 2000) (invalidating an EPA rule because of evidence that it would not produce gains).

alleviated without risk reduction, then government can reasonably engage in risk reduction, at least if the relevant steps are justified by an assessment of costs and benefits.[233]

233. I have not said anything here about the difficult issue of how to monetize public fear.