Dreadful Possibilities, Neglected Probabilities

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Dreadful possibilities stimulate strong emotional responses, such as fear and anxiety. Fortunately, most high-consequence negative events have tiny probabilities, because life is no longer nasty, brutish and short. But when emotions take charge, probabilities get neglected. Consequently, in the face of a fearsome risk, people often exaggerate the benefits of preventive, risk-reducing, or ameliorative measures. In both personal life and politics, the result is harmful overreactions to risks.

One salient manifestation of probability neglect is that in two situations involving the same dreadful possibility, one much more likely to unfold than the other, individuals may value risk elimination nearly equally even though probabilities may differ by a factor of 20 or more. People focus on the bad outcome itself, and are inattentive to how unlikely it is to occur – hence their overreaction when the risk is low.

In other words, those who suffer from probability neglect would give up too much to wipe out a low-probability risk (moving from 0.001 to 0.000). They will frequently take excessive preventive action.[1] Corporations and governments suffer equivalent fates, in part because they need to respond to individuals and in part because of their own natural tendencies. Patt and Zeckhauser labelled such overreactions as *action bias* in a 2000 article in the Journal of Risk and Uncertainty. That bias is especially likely if the relevant actors are able to obtain credit from themselves or the public for responding to the risk.

It is predictable that following a terrorist attack, the public will both alter its behavior and demand a substantial governmental response. That will be true even if the magnitude of the risk does not warrant such a response, and even if the danger is far less than that presented by other hazards that inspire less dread. Consider, for example, the possibility that extensive security precautions at airports will lead people to drive rather than to fly; because driving is much riskier than flying, such precautions might cost many lives on balance. Further, the monies spent in recent years on airplane security seem out of scale with the level of risk reduction produced, particularly since numerous tests have found that the screening routinely fails to find weapons.

Perhaps such screening, however low the risk or ineffective the preventive, does reassure the public. If so, it serves a positive function, not unlike the nighttime hoof clops of mounted police, which make very peculiar and recognizable noise. Squad cars may be better at deterring or catching criminals, but hoof clops are superior for fear reduction. The same points apply of course to many other purported forms of risk reduction, including measures to prevent financial crises, local steps to reduce greenhouse gas emissions, and regulation of abandoned hazardous waste dumps. Financial crises have a distinctive element: the fear itself may be a major

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[1] The converse is also true. If emotions lead to the neglect of probabilities, there will be insufficient response to a given reduction in probability for high probability risks ("I'm sure it's going to happen anyway").

stimulant for the crisis. As people sell in response, the downdraft accelerates, as we have seen in 2008 and 2009. Panics make reassurance that much more critical.

In the personal as opposed to social domain, we can find many analogues, as when people alter their travel plans to avoid slight risks of crime, restructure their portfolios to avoid small risks of big financial losses, or change their diets to avoid minimal health risks.   Probability neglect promotes overreaction. The costs of overreaction may be reduced assets (restructuring the portfolio), increased risk (driving rather than flying), or sacrificed pleasure (children forgoing Halloween due to extremely rare razor-blade incidents).

Demonstrating probability neglect

Prospect theory was developed by Daniel Kahneman and Amos Tversky in their seminal 1979 publication. It tells us that the perceived benefits of risk reduction will be much less than proportional to the risk avoided, since the function relating the weights that probabilities are given to the underlying true probabilities is relatively flat for small but positive probabilities. However, prospect theory alone gives no indication that the ratio of weights would change dramatically with the nature or with the description of a risk.

Experiments on probability neglect seek to assess whether attention to probability could be overshadowed by attention to the emotional impact of the outcome, quite contrary to what leading theories of decision making posit. Emotional activity appears to dampen cognitive activity. Loewenstein and Lerner (2003) observe that: "As the intensity of immediate emotions intensifies, they progressively take control of decision making and override rational decision making." We would expand this assertion to include overriding well-documented behavioral patterns in decision making, such as those described by prospect theory. This suggests that a dreaded scenario could swamp or at least temper the importance assigned to dramatic probability differences.

Electric shocks

Some of the relevant experiments explore whether varying the probability of harm would matter less in settings that trigger strong emotions than in those that are relatively emotionally neutral. One such study explored people's willingness to pay (WTP) to avoid electric shocks, in an effort to test the relevance of variations in probability to "strong-emotion" decisions (Rottenstreich and Hsee, 2001). 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." In the relatively low-emotion setting, they 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%. 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.

The electric shock results reveal substantial probability neglect. The median subject was willing to pay $7 to avoid a 1% chance, but only $10 to avoid a 99% chance – a mere 1.43 times as much despite a 99 times increase in risk. (For the $20 penalty, the corresponding ratio was 18 times as much.)

The conclusion is that when a hazard stirs strong emotions, most people will pay an amount to avoid it that varies little even with extreme differences in the starting probability. What we are stressing here is that when the probability of loss is very low, people will tilt toward excess action. They will favor precautionary steps even if those steps are not justified by any plausible analysis of expected utility.

For either social or personal risks, the implication is clear. When the potential loss is likely to trigger strong emotions, overreaction occurs, as it does when the loss is an economic meltdown, environmental catastrophe, terrorist attack, cancer death, or getting killed in a plane crash. Even if the likelihood of a terrible outcome were extremely low, people would be willing to pay a great deal to avoid it, whether through public or private action. Once a risk is in people's minds, their willingness to pay to avoid it will often be relatively impervious to significant changes in probability. The significant and often expensive precautions taken against possible sniper attacks by citizens of the Washington, DC area in October 2002 provide a dramatic example; they attest to the phenomenon of probability neglect in the face of a vivid threat. Indeed, some of these precautions, such as driving great distances to gas stations in Virginia, almost certainly increased mortality risks on balance.[2]

Arsenic in drinking water

To investigate the possibility that values for eliminating low probability fearsome risks get overblown, we asked law students to state their maximum willingness to pay to reduce levels of arsenic in drinking water. The questions were drawn from real life. They were based on actual choices confronting the U.S. Environmental Protection Agency, involving cost and benefit information approximating actual figures used by the agency itself.

Participants were randomly sorted into four groups representing the four conditions in a 2x2 experiment, where both the probability and the description of the risk varied. In the first condition, people were asked to state their maximum willingness to pay to eliminate a cancer risk of one in 1,000,000. In the second condition, people were asked to state their maximum willingness to pay to eliminate a cancer risk of one in 100,000. In the third condition, people were asked the first question, 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 condition, people were asked the second question, but the cancer was described in the same vivid terms as in the third condition. In each condition, participants were asked to check off their willingness to pay among the following options: $0, $25, $50, $100, $200, $400, and $800 or

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[2] When the risk is imposed by malicious people, there is often a negative externality from the precautions taken by any individual. Those who went to Virginia to fill up made it more dangerous for D.C. fillers. When few citizens walk in an urban area at night, those who still walk find such activity more dangerous.

more. Notice that the description of the cancer in the "highly emotional" conditions added little information, since many cancer deaths bear these characteristics. Indeed, finding a significant difference between the two descriptions would be telling, since the word cancer in general elicits dread.

Here are the results in tabular form:

Table 1. Willingness to Pay in Dollars for Elimination of Arsenic Risks

Harvard Law School Results, 2008
Mean (Median)
[Number of Subjects]

Probability	Unemotional description	Emotional description
1/100,000	241 (100) [20]	250 (100) [13]
1/1,000,000	59.21 (25) [19]	211 (200) [15]

The study was conducted in two law school venues, the University of Chicago (Sunstein, 2002) and Harvard Law School. At Chicago, the medians were 100 and 25 for the unemotional description, and 100 and 100 for the emotional description. While the sample size was too small to permit firm conclusions, the qualitative results pointed in the hypothesized direction. The emotional description drove out responses to the quantitative difference in the risk.

At Harvard, as shown and hypothesized, the valuations for the more emotional description hardly differed even though probabilities differed by a factor of 10. Indeed, WTP was actually higher for the 1/1,000,000 probability given the emotional description, though far from significant. By contrast, for the unemotional description the willingness to pay (WTP) for the 1/100,000 probability was far higher.

It is important to note that the difference in WTP, even for the unemotional description, was far below the 10 to 1 odds ratio; for the ratio of the means was roughly 4 to 1. Both hypotheses were therefore supported. First, varying the probability had an effect on WTP that was much less than rational decision theory would predict. (Future research should assess whether even mentioning the word "cancer" induced sufficient emotion to reduce a 10 to 1 to a 4

to 1 ratio.)   When the cancer was described in affectively gripping terms, people were insensitive to probability variations.[3]

Implications of the Results

These findings have two implications for overreactions. They suggest, first, that when extremely low probability risks give rise to dread, they are likely to trigger a larger behavioral response than statistically identical comparisons involving less fearsome possibilities. Here, as in the experiment, there will be a kind of "emotion premium." The findings suggest, second, that probability neglect will play a role in the private and public reactions to emotionally gripping dangers, and that many people will focus, much of the time, on the emotionally perceived severity of the outcome, rather than on its likelihood.

In this light, it should not be surprising that our public figures and our cause advocates often describe tragic outcomes. Rarely do we hear them quote probabilities. The latter, even if reasonably large, would have little salience in the public debate.

Emotions beyond fear also may drive probability neglect. Consider outrage, an emotion stirred when low probability risks are created from the outside, as they are with nuclear waste radiation. A similar risk from radon exposure comes from one's own basement; hence no outrage. Outrage can overshadow probabilities in much the same way as fear can, reinforcing our finding that emotional activity dampens cognitive activity. A central finding of relevant empirical work is consistent with that stressed here: a large difference in probability had no effect in the "high outrage" condition, involving nuclear waste, but a significant effect in the "low outrage" condition, involving radon. People responded the same way to a high-outrage risk of 1 in 100,000 as to a risk of 1 in 1,000,000 (Sandman et al., 1998). Even when both the statistical risk and ultimate consequences were identical in the high outrage (nuclear waste) and low outrage (radon) cases, people in the nuclear waste case reported a much greater perceived threat and a much higher intention to act to reduce that threat. 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" (Sandman et al., 1998).[4]

In this light, it is not surprising that visualization or imagery matters a great deal to people's reactions to risks. Vivid images can produce palpable overreactions as Slovic and coauthors show in their work on the affect heuristic. When an image of a bad outcome is easily accessible, people will become greatly concerned about a risk (Loewenstein et al., 2001). An interesting anomaly is that when people are asked how much they will pay for flight insurance

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[3] We found similar results in a revised version of the electric shock experiment (Sunstein and Zeckhauser, 2008). There was no significant difference between what people would pay to eliminate a 1% chance of a shock and a certain shock.

[4] An alternative explanation is that individuals demand substantial compensation for their outrage, and that such compensation is both fairly independent of the probability and large relative to the compensation for risk. Note that efforts to communicate the meaning of differences in risk levels by showing comparisons to normal risk levels, reduced the effect of outrage; but only modestly so. Outrage had nearly the same effect as a 2000-fold increase in risk (Johnson et al.,1993)). Did this information provision improve cognitive uptake directly, or indirectly because it dampened the outrage? Further experiments will be required to tell.

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 (which by definition also includes terrorism) (Johnson et al., 1993).[5] The likely explanation for this peculiar result is that the word "terrorism" evokes vivid images of disaster, outrage, or both, thus inhibiting judgments about probability differences. Note also 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 (Alhakami and Slovic, 1994). The discussion helps them to visualize the risk, thus making it more frightening. The most sensible conclusion is that with respect to risks of injury or harm, graphic images of disaster can overwhelm the cognitive activity required to conclude that the probability of disaster is actually small.

Conclusion

Dreadful possibilities activate emotions and make people insensitive to the probabilities of harm.[6] Terrible outcomes that are easy to visualize trigger large-scale changes in thought and behavior even if the statistical risk is dramatically lower than those associated with many other activities with equivalent stakes that do not arouse public concern. Probability neglect helps to explain public overreaction to highly publicized, low-probability risks, including those posed by sniper attacks, abandoned hazardous waste dumps, anthrax, and perhaps more generally, terrorism.

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[5] This should bring to mind a component of the embeddedness phenomenon known from contingent valuation surveys. If seals are appealing and easily visualized, it is not surprising that we might pay more to save them in an oil spill than to save all wildlife.

[6] In future work, we expect to examine the complementary concept of payoff neglect: when emotions run high, the size of potential losses will tend to be slighted. The emotion may be stimulated by anger directed at the source of the risk, or merely by a vivid description of the risk itself, apart from its magnitude.

Acknowledgements

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