

Virgin vs. Experienced Risks

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Introduction

Every day we face a multitude of risks. Some we have experienced before; some we have not. Some we have contemplated; others have never crossed our mind. In this essay, we define four types of risk based on these two dimensions: whether or not they have occurred and whether or not they have been contemplated. These four classes of risks are shown in Figure 1. Most of our analysis will be addressed to virgin and experienced risks, those falling in the upper-left and lower-right hand boxes. Individual and societal responses to these four types of risk will vary in predictable ways. Here, we focus on individual and societal learning about a risk following the occurrence of an extreme event.

Our first category of risks is virgin risks, which we define as those risks for which we have never experienced an event and for which there has also been no recognition of the possible risk. Virgin risks are out of mind. Risks can occur at the level of society, or the level of the individual, or both. For an individual, a car crashing into their living room is likely a virgin risk. Even if a few individuals foresaw trouble in the mortgage market, for society, the September/October 2008 meltdown in securities markets, with major financial firms going under, was the occurrence of a virgin risk. (While this specific financial crisis had not previously occurred, inferences could have been drawn from what we call resembled risks, such as the Great Depression. This is discussed in section 3.3.). Of course, if risks are of sufficiently low probability to be virgin risks, we should only be concerned with them if they are high consequence.

Our second category of risk, contemplated risk, is those risks for which there has not been a past occurrence, but for which there is recognition of the risk. For an individual that has never had a heart attack, the possibility of one is a risk that falls in this category. For society, the chance of an avian flu pandemic is a contemplated risk – a massive outbreak has not yet occurred, but there are those in government and the private sector that are taking precautions and preparing response plans, should a pandemic arise, and newspapers discuss this possibility.

Our third category of risks is experienced risks. These are risks we both recognize and have experienced before. Fender benders, computer crashes, and catching the flu are all experienced risks for individuals. For society, war is an experienced risk, for example. Our final category is neglected risks. For neglected risks, there has been a past occurrence, but individuals or societies are not currently contemplating another, usually because the prior example is remote. An example is an asteroid colliding with the earth. Exactly 100 years ago, an asteroid had an air burst over Tunguska, Siberia creating an explosion 1,000 times as powerful as the atomic bomb on Hiroshima and toppling 80 million trees. But an asteroid-caused explosion is a risk that has drifted out of public consciousness into the category of neglected risk (exempting NASA's Asteroid and Comet Impact Hazards Group).

For many risks, we do not know the probability distribution of an event occurring and often, the distribution may be changing over time. In these cases, even experts must rely on conjectural or subjective assessments of the risk, as we see with climate change. When new

information comes to light, such as a two mile long ice core from Antarctica that extends the climate record back an additional 210,000 years, experts update their assessment of the risk (Brook 2005). For ordinary people and the political process, a dramatic event, such as 9/11, is usually the key source of new information about a risk. Scientific studies, by contrast, rarely change public prior beliefs dramatically. A rational observer, following the occurrence of an event, would update her assessment of the risk using Bayes' Rule. Applying that law requires more than intellectual understanding, namely it requires both prior probability assessments and likelihood functions. Unfortunately, most people are not equipped mentally or mathematically to be rational in this manner, and prior probability assessments and likelihood functions are often hard to come by.

With Bayes' Rule not usable in many situations, individuals and society will learn from extreme events in a haphazard and often biased fashion. In this paper, we explore three conjectures about individual and societal learning from the occurrence of an extreme event based on whether an event had previously occurred and whether or not it was "out of mind." The three conjectures are:

- 1) After the occurrence of a virgin risk, we tend to over-update our assessment of the likelihood that one will occur again. After the occurrence of an experienced risk, on the other hand, we tend to under-update our assessment of the risk.
- 2) After the occurrence of a virgin risk, we fail to appropriately update our assessment that another, different virgin risk could occur.
- 3) We fail to consider resembled risks, leading us to be surprised by risks we should not be and preventing us from updating related risks after the occurrence of an extreme event.

These biases in updating will lead to suboptimal decisions about risk-mitigating and risk-spreading activities.

Our discussion is firmly rooted in the behavioral decision tradition and the risk and decision making work pioneered by Howard Kunreuther, particularly his findings that people are severely biased in their assessments of probabilities of catastrophes. The next section of the paper discusses why individuals cannot be expected to rationally update their risk assessments using Bayes' Rule. Section 3 explores each of the three conjectures above, providing suggestive evidence of their veracity and a discussion of their theoretical underpinnings. Section 4 concludes.

2. The Inability to Use Bayesian Updating in Everyday Practice

In situations where the distribution of a risk is unknown, the textbook model for how to update subjective risk assessments is to employ Bayes' Rule. Individuals first form a prior distribution on the parameter of interest, the probability p . This prior will depend on the information available. Let us denote the information available initially as i . The prior distribution is then $f(p|i)$. An event occurs, giving new information e . After the event, individuals update their prior distribution given the new information e , to form a posterior distribution $f(p|e, i)$ (e.g., Morgan and Henrion 1990). This is calculated using Bayes' Rule:

$$(1) \quad f(p|e, i) = \frac{f(e|p, i) * f(p|i)}{\int f(e|p, i) * f(p|i) dp} .$$

As seen in equation (1), Bayesian updating requires sophisticated computations and even experts, unless trained in statistics or decision theory, are unlikely to intuitively update their risk

assessments in this fashion. Frequently our interest will not be in the entire distribution, but in the expected probability of an event occurring in the future, namely $\bar{p} = \int_0^1 p * f(p | e, i) dp$.

Apart from the difficult calculations, there are several other reasons Bayesian updating is unlikely to be used in everyday assessments. First, individuals and policymakers are unlikely to have priors in their heads, especially for virgin risks. There are many risks individuals simply do not ever consider. Not thinking about every possible risk before it occurs is a perfectly logical way to organize one's life. It reflects the expected utility of not thinking about every way one could reap expected utility (or disutility). But we hardly wish to argue that just because it is rational not to think about every possibility, the neglect of all risks in the world makes sense. In the late 1970s, Kunreuther studied flood and earthquake insurance purchases in California. He discovered that people in flood- and earthquake-prone areas often neglected the risk, failing to purchase insurance, even when it was significantly subsidized (Kunreuther 1978). These individuals were not ignoring a 1 in 100,000 possibility, but perhaps a 1 in 100 or 1 in 50 possibility, and one with grave consequences that could be avoided at an affordable price.

If someone could not and did not previously contemplate a risk, one might think their prior probability of it occurring was zero. Once an event occurs, however, it can happen again, making the posterior probability positive. This represents an update at an infinite multiple, a logical impossibility. But surely any rational person confronted with a virgin risk that has now happened would go back and reconsider what his prior should have been had he thought about the possibility. Thus, although Carl Glatfelter Jr. of McSherrystown, Pennsylvania never considered the possibility that a car would come crashing through the front wall of his home, pushing him through a back window (McCune 2008), if he had been forced to place a probability on it, he might have given it a 1 in 100,000,000 chance per year.

There are many difficulties, however, with attempting to recreate a prior ex-post. Individuals have a notoriously difficult time assessing what their prior would have been had they merely thought of the event before it actually occurred. For instance, like the man who never thought about a car crashing into his house, prior to 9/11, most Americans had never even considered the possibility of a terrorist attack in this country at the level we experienced. After it occurred, an attack of that magnitude – or something worse – was not beyond belief, and indeed was thought to have a positive probability of happening again. Thus, for the majority of Americans, their subjective assessment of terrorism risk should have been far higher after 9/11 than before. Even though we undertook measures to lower such risks after 9/11, this should still be the case, since prior to the attack the risk was considered by most to be virtually outside the realm of possibility, such that the update in probability should overwhelm any response to it that may have lowered the objective risk.

In a study that surveyed law school students about their beliefs, however, it was found around 40% of respondents believed that their personal risk assessment was higher before the attacks than it was currently (Viscusi and Zeckhauser 2003). In another study of professional school students and undergraduate business students, the authors find the same phenomenon, with over two-thirds of respondents thinking their assessment of terrorism risk did not increase post 9/11 (Viscusi and Zeckhauser 2005). The authors employ the term “recollection bias” to refer to the phenomenon whereby after the occurrence of a low-probability one thinks that one's a priori risk assessment was much higher than it actually was.

This is a variant of hindsight bias (e.g., Fischhoff 1975), in which knowing the outcome of an event alters an individuals' assessment of how likely it was to have occurred. For example,

Fischhoff (1975) gave subjects passages to read about the Gurkha raids on the British in the early 1800s. Some subjects were told how the conflict ended and others were not. When asked what the probability of occurrence of each outcome was, those who knew the outcome gave it a much higher probability. With so-termed “secondary hindsight bias,” individuals are unaware that the occurrence of an event influences what they believe ex-post that they would have estimated ex-ante (Kelman, Fallas et al. 1998). This bias prevents individuals, in situations of uncertainty, from accurately reconstructing priors after an event, making Bayesian updating, putting aside the complicated calculations which make it difficult to update any risk, especially unlikely to perform well for virgin risks.

Even if individuals, looking in retrospect, could accurately assess the prior probability they would have attached to an event had they thought about it, there is another complication. To update their prior probability, they need two additional pieces of information. The first is relatively straightforward. They need to define how much information they had relative to the new information from the event. It is often convenient to think of such situations in terms of binomial trials. In a previous paper, two of the authors examined what could be inferred about the magnitude and frequency of events after the occurrence of one incident, but for which the threshold of event that would have generated notice is unknown (Pratt and Zeckhauser 1982). In that paper, Pratt and Zeckhauser highlight some of the cases where an event occurs and knowledge of the number of trials can be taken as given, such as an adverse reaction to a drug in a cluster of people, where the total number of pills produced is known.

While there are many such cases, there are also others where it is unclear how many “trials” have occurred. For instance, knowing how many trials there have been of potential terrorists attacks is difficult to determine, especially if one is not privy to classified information. It is also not clear how such information would cut. Would you rather live in a world where there had been 100 terrorist trials, and only 1 had been successful, or a world in which there had been 3 trials, and 1 had been successful? In the first case, you know our defense is better. In the second, you know that fewer attacks are coming our way.

The second piece of information needed for Bayesian updating is a challenge for even the most sophisticated of decision makers, at least for many types of events. The individual needs to have more than their prior probability that the event would have occurred. They need to have a probability distribution over that probability, which would enable them to update once an event happens. Consider the difficulty. An event occurs for which an individual concludes that before the event she would have thought the likelihood of that event happening was p^* . Now she has to go one step deeper, and think of how likely she was to think it was various values of p likely. That is, she has to define $f(p)$, where $\int pf(p/i)dp = p^*$. The challenge of defining $f(p)$ strikes us as almost beyond the bounds of human capability for those not trained in decision analysis, and indeed for many who are so trained.

Although an ideal to which we should aspire, effective use of Bayes’ Rule is clearly unlikely in most everyday situations. Instead, individuals are updating their risk assessments in an ad hoc fashion, likely employing many of the well-documented heuristics individuals use when making decisions under uncertainty and falling prey to many of the biases (Kahneman, Slovic et al. 1982).

3. Updating as a Function of Previous Experience and Previous Contemplation

We just discussed why, in most situations, individuals and society will fail to update using Bayes’ Rule. In this section, we explore three specific conjectures about how updating

behavior can be influenced by whether an event has occurred before and whether it has been considered before.

3.1 After the occurrence of a virgin risk, we over-update our assessment of the likelihood that one will occur again. After the occurrence of an experienced risk, on the other hand, we tend to under-update our assessment of the risk.

Our first conjecture is that individuals will excessively update their assessment of virgin risks after one occurs, and fail to (or barely) update their assessments of experienced risks, even when significant updating is warranted. Some experienced risks are well understood systems with a large amount of frequency data, justifying little updating. However, for many other experienced risks we have far fewer observations than we perceive and/or the risk is changing over time. In these latter cases, individuals should update their risk assessments more than they tend to do in practice.

First, we present an example from flood risk where there was excessive updating following the occurrence of a virgin risk, yet lack of appreciable updating after the occurrence of an experienced risk, even though data is scarce on that risk and it is evolving over time. While a lack of data and knowledge of individual priors prevents us from comparing the updating that occurred with how individuals should have updated had they used Bayes' Rule, this example does provide suggestive evidence of a tendency to over-update virgin risks and under-update experienced risks, certainly on a relative basis.

Flood events can be an experienced risk for those who live on the banks of a river or the coast, and whose property has been flooded in the past, though perhaps only rarely. Others, who live further from the water's edge or on higher ground, may never have been flooded, but a very rare, extreme flood event could inundate their property. For these two classes of homeowners, flood events would be respectively experienced and virgin risks. Estimates of how flood risk is capitalized into property prices can give some indication of a homeowner's perception of the magnitude of the risk. This was done for St. Louis County, Missouri, located just below the confluence of the Missouri and Mississippi Rivers. The changes in property sales prices both in and out of the floodplain following the devastating 1993 flood on the Missouri and Mississippi Rivers were examined to determine how homeowners' assessment of the risk changed following an extreme event (Kousky 2008).

During the 1993 flood, which was a record flood event for the region, 100-year floodplains were inundated and many 500-year floodplains were as well, particularly those behind failed levees. 100-year floodplains represent an area of experienced risks; floods have previously occurred in these areas and the flood hazard is widely recognized with national regulations requiring disclosure of the flood risk to homeowners and those with a mortgage required to purchase a flood insurance policy. 500-year floodplains had not been flooded, at least in recent times, and the risk in these areas was also out-of-mind, with no information disclosure or insurance requirements. Flooding in these areas, therefore, represented the occurrence of a virgin risk.

After the 1993 flood, property values in 500-year floodplains – including those that did not get flooded but which were then recognize as being at risk – had a statistically significant decline in price of about 3% on average. All property values in municipalities located on one of the flooded rivers dropped in price by a statistically significant 6 to 10% compared with property in the interior of the county. This suggests dramatic updating of the risk. On the other hand,

there was no statistically significant change in property values in the 100-year floodplain, suggesting little to no updating of the risk.

Homeowners in 100-year floodplains should have updated their risk assessments for three reasons. First, there is insufficient experience to know the probability of a flood with any precision. While there is a data on flood events in St. Louis going back to Lewis and Clark, for an event thought to occur perhaps once a century, the time series is not nearly large enough to provide a tight estimate on its likelihood. Second, the risk is evolving. Flood risk has been shown to be increasing over time in the St. Louis area due to structural changes to the river, increased development, and possibly climate change (e.g.: Deyle, French et al. 1998; Wuebbles and Hayhoe 2004; Ehlmann and Criss 2006). Third, the expected consequence of an event represents a combination of its likelihood and its severity. The floods in 1993 were much more severe than anything previously experienced. There should have been an update on severity, an unknown beyond probability, and surely a factor that affects housing values.¹

We draw on two findings from behavioral economics to explain this updating behavior, one from Prospect Theory and the other related to the Availability Heuristic. One finding of Prospect Theory is that individuals place excess weight on zero (Kahneman and Tversky 1979). The Russian Roulette problem provides an illustration of this phenomenon. Most people are willing to pay more to remove one bullet from a six-cylinder gun when it is the only bullet than if there are two (or more) bullets in the gun. That is, a reduction in risk from 1/6 to zero is worth more to them than the reduction from 2/6 to 1/6, even though they are equal reductions in probability.²

Similarly, our argument here is that people perceive a large consequence when a risk moves from 0% to a small positive amount, say, 0.1%, but very little consequence when a risk increases by an equal amount from an already positive probability, say, 5% to 5.1%. This perception leads to excessive updating for a previously virgin risk and barely any updating for an experienced risk. Consider, for example, the occurrence of an event that previously was not contemplated. Posit further that fully rational updating would change a risk from 0.01%, what is effectively 0, to 1%, namely a 100-fold increase. We conjecture that individuals might instead produce a posterior risk assessment of say 5%, a value 5 times too high.

Figure 2, Responses to Risk Changes, is derived from Figure 4, a hypothetical weighting function, in the original Prospect Theory paper (Kahneman and Tversky 1979). Here we use perceived probabilities instead of decision weights. Thus, our graph essentially presents the derivative of the curve in their Figure 4. Our interest is in the change in perceived probability for a tiny increase in assessed risk. Note that at point A there is a big jump, i.e., a discontinuity, when the probability goes from 0 to positive. That suggests why virgin risks might be excessively updated. But for small experienced risks, such as say 1%, the change in perceive

¹ Note, if the 1993 floods, say, quadrupled expected losses in the two different floodplains, the effect on housing values in the 100-year floodplain should have been much greater, contrary to our findings, but consistent with our conjectures. The factor by which properties in the 500-year floodplain are updated may be greater than in 100-year floodplains, but the absolute amount could be less. For example, houses in the 100-year floodplain may already be reduced in price 18% and those in the 500-year floodplain by 1%. A flood occurs and the homes in the 100-year floodplain have a factor of 3 update, while those in the 500-year floodplain have a factor of 5 update. The factor is thus smaller, but the absolute change in price is larger in the 100-year floodplain.

² This example, due to Zeckhauser, is cited in Kahneman and Tversky (1979), p. 283. An individual with no dependents should pay more to get rid of 1 out of 2 bullets, because 1/6 of the time she would be dead anyway, a state in which money has lower value.

probability per unit increase in probability is tiny, suggesting why low-level experienced risks are hardly updated.

The enormous change in perception when a probability goes from 0 to positive is consistent with evidence from other areas. For instance, the theory of just noticeable differences explores the smallest change in a sensory perception that a human can detect. The Weber-Fechner Law states the change in a sensory perception needed for it to be perceived increases with the base level intensity of the stimulation. That is, for example, as things get louder, small changes in volume are harder to perceive. This is similar to our argument that as base probabilities get larger, small changes in probability are not perceived as well.

Experienced risks present a far different picture. Consider a low-level experienced risk. An increase in probability, as shown in Figure 2, barely registers, which may explain why such risks would get little updating. There also may be some heuristic confusion with situations where experience is much more extensive. In these cases, another occurrence appropriately tells us nothing. For example, if it rains on March 8 this year, it tells us nothing about the likelihood of rain next year on or near that date. If, however, we have less experience than we think we have, say we are only going on personal recollection, greater updating is needed. For instance, while we often assume we have substantial experience with flood events, for floods that occur once every 100 years, or even less frequently, even if the process were unchanging, many, many hundreds of years of data would be needed to accurately assess the probability of a flood in a given year. Such a long time series of data is rarely available. Our basic argument is that for most of the low probability experienced risks of great interest that affect society as a whole, we have relatively little experience. That means that updating should often be substantial. Similarly, if we know the distribution of a risk is changing over time, the occurrence of an extreme event should lead to more substantial updating.

The Availability Heuristic provides another explanation of our first conjecture. The Availability Heuristic tells us that individuals assess the likelihood of an event as higher when examples come to mind more readily (Tversky and Kahneman 1973). Once an event has occurred, it is much more salient, leading individuals to think it is more likely to occur. This could be another explanation for over-updating following the occurrence of a previously virgin risk. While the occurrence of a risk that had previously not occurred makes it quite salient, the third occurrence, say, after there have been two already, likely does not add much to the availability of a risk. This would explain the relatively little updating done for risks that have been previously experienced.³

3.2 After the occurrence of a virgin risk, we fail to appropriately update our assessment that another different virgin risk could occur.

Once a low-probability virgin risk occurs, individuals should update their assessment of the likelihood that any other virgin risk would occur. Similar to the Bayesian catchall hypothesis, which refers to all other hypotheses, we define a “catchall category” composed of all risks that have not been previously experienced or contemplated. When a risk occurs from this category, not only should the likelihood of that specific event occurring again be updated, but the likelihood one assigns to the possibility that any event from the catchall category occurring should also be updated. We presume that in practice this is rarely done. Even worse would be to conclude after a virgin risk that since we have dealt with the particular risk, and presumably

³ Interestingly, if updating requires multiplying likelihood ratios, as is usually the case, the absolute increment in posterior probability going from the 2nd to the 3rd occurrence should be greater than going from the 1st to the 2nd.

some of its unknown cousins, other risks of its type are less likely to occur. Even if we take actions against such risks, say better prepare for any unknown epidemic after a specific one has occurred, which reduces their former true probabilities, their assessed likelihoods may have increased. Thus, after 9/11, the risk of terrorist losses, say due to contamination of water supplies, probably increased.

There are times when the occurrence of a previously virgin risk leads us to consider other virgin risks and to update our assessment they will occur. But even then, such specific updating is often ad hoc and not as comprehensive as it should be. As one example, after the coverage of Katrina in September, 2005 subsided, mention in the news media of avian flu jumped dramatically (see Figure 3). This need not necessarily indicate changes in perceived probability, as it could be due to more space in the media or more interest in risks, but it is certainly suggestive of updating. Another risk Katrina led us to consider was earthquakes. In the weeks following Katrina, editorials across California papers warned of the risk of a major earthquake and asked if Californians were prepared (e.g., "California's Hurricane" 2005; "Facing Disaster" 2005). This is a type of contagion effect in risk contemplation and future research will examine why such contagion occurs across some classes of risks but not others.

3.3 We fail to consider resembled risks, leading us to be surprised by risks we should not be and preventing us from updating related risks after the occurrence of an extreme event.

There is a natural clustering of groups of risks, which we label *resembled* risks. These are risks that are similar to each other in key respects that make the appropriately assessed probabilities of those risks positively correlated. After an event occurs, we often fail to draw the parallels to other resembled risks, leading us to be surprised by events that should not surprise us. In other words, there are many virgin risks that should be contemplated risks, and many neglected risks that should be experienced risks. We present two examples: the terrorist attacks in September 2001 and the 2008 financial meltdown. Both the public and the government treated these like virgin risks, but there was ample information that they were resembled risks from past events. Drawing information from resembled risks can help prevent what Max Bazerman and Michael Watkins label predictable surprises, which are events “that take an individual or group by surprise, despite prior awareness of all the information necessary to anticipate the events and their consequences” (2004).

The 9/11 attacks were treated as a virgin risk by many. This can be seen by examining the way in which the attacks were discussed by public officials, in the news media, and between citizens on the street. A specific example of dramatic updating after 9/11, such as we postulate occurs after a virgin risk, comes from the insurance industry. Prior to the September 11th attacks, insurance companies did not exclude terrorism from their coverage. The shock to the insurance industry regarding the magnitude of claims led reinsurers and then insurers to leave the market for terrorism insurance – evidence of significant updating of risk assessments. This left firms in the United States unprotected, leading to the passage of the Terrorism Risk Insurance Act in 2002, which provided heavily subsidized federal reinsurance.

But 9/11 should not have been so unexpected. After all, just three years earlier al Qaeda had blown up the U.S. embassies in Dar es Salaam and Nairobi, and continued to issue threats. In 1993 the World Trade Center had been attacked by a car bomb that killed 6 and injured more than 1,000, though it failed to bring down the towers. These resembled risks should have led individuals and society to increase their assessment of the likelihood of larger scale terrorist attacks. Of course, other information apart from resembled risks should also be drawn on in

making such assessments. As discussed by Bazerman and Watkins (2004) in regards to 9/11, the inadequacy of airline security was well documented, the growing hatred of the U.S. among Islamist extremists was no secret, and intelligence officials were aware of the strategy of multiple hijackings.

As another example, while the 2008 financial meltdown took many by surprise, by examining resembled risks, the meltdown should not have been as virgin of a risk as it appears to have been. Shrewd observers would have witnessed the real estate and stock market crash of Japan in the 1990s, the Asian financial crisis of 1997, or perhaps the more than 75% drop in NASDAQ prices from March 2000 through October 2002 as events that merited updating for both a dramatic bubble followed by massive price declines. This failure to draw inferences from related risks is a serious problem for effective risk avoidance.

One cause of this behavioral tendency to restrict extrapolation may represent a certain type of mental inertia, perhaps a cousin of cognitive dissonance. When everything is going along fine, our mind tends to stick in the same track. It readily ignores warning signs that the world may have changed, even if those signs are fairly prominent, as they were in both of these cases. This raises the general issue of how to update low probability events in the absence of salient instances, a subject for future analyses, and of particular relevance to climate change.

The flip side of failing to recognize the likelihood of resembled risks before an event occurs is failing to draw inferences to other resembled risks after an event occurs. For example, while it strikes us as extremely unlikely that there will be another financial meltdown in the foreseeable future associated with a punctured bubble in housing prices and a disastrous failure of opaque derivatives, the experience of 2008 should tell us that financial collapses, bringing with them the failure of strong corporate entities, are much more likely than we thought.

There are, of course, some times when an individual or society is able to recognize a resembled risk and take preventive action. For instance, after the 2004 tsunami in the Indian Ocean, Congress and the President developed a plan for early detection and warning of tsunamis that could threaten U.S. coasts. This was, in effect, an updating of the probability that the U.S. could be threatened by a tsunami. Future research should explore when and why some resembled risks are recognized, leading to mitigating activities, and why others are not.

4. Conclusion

We presented three conjectures about human failures in extrapolating from the observance of low-probability, high consequence events to predictions about future events. Our virgin risks discussion suggests that we may well overcorrect. The particular disaster, now both available and salient, is likely to be overestimated in the future. By contrast, there may be a tendency to under update when a risk with which we are already familiar occurs. Finally, evidence from both terrorist incidents and financial markets suggest that we may have difficulty extrapolating across even fairly similar types of risks.

Future research should document these tendencies with many more examples, and in laboratory settings. If improved predictions are our goal, it should also provide rigorous statistical models of effective updating of virgin, experienced, and resembled risks.

Figure 1. Typology of Risks

	Out of Mind	Recognized
No Occurrences	Virgin Risks	Contemplated Risks
Past Occurrences	Neglected Risks	Experienced Risks

Figure 2. Responses to Risk Changes

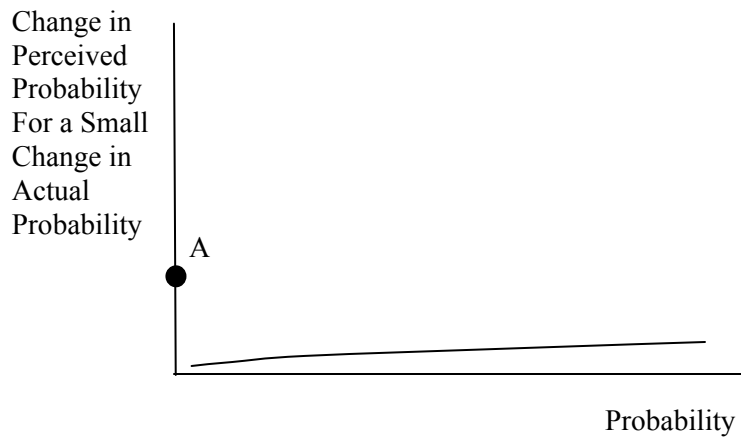
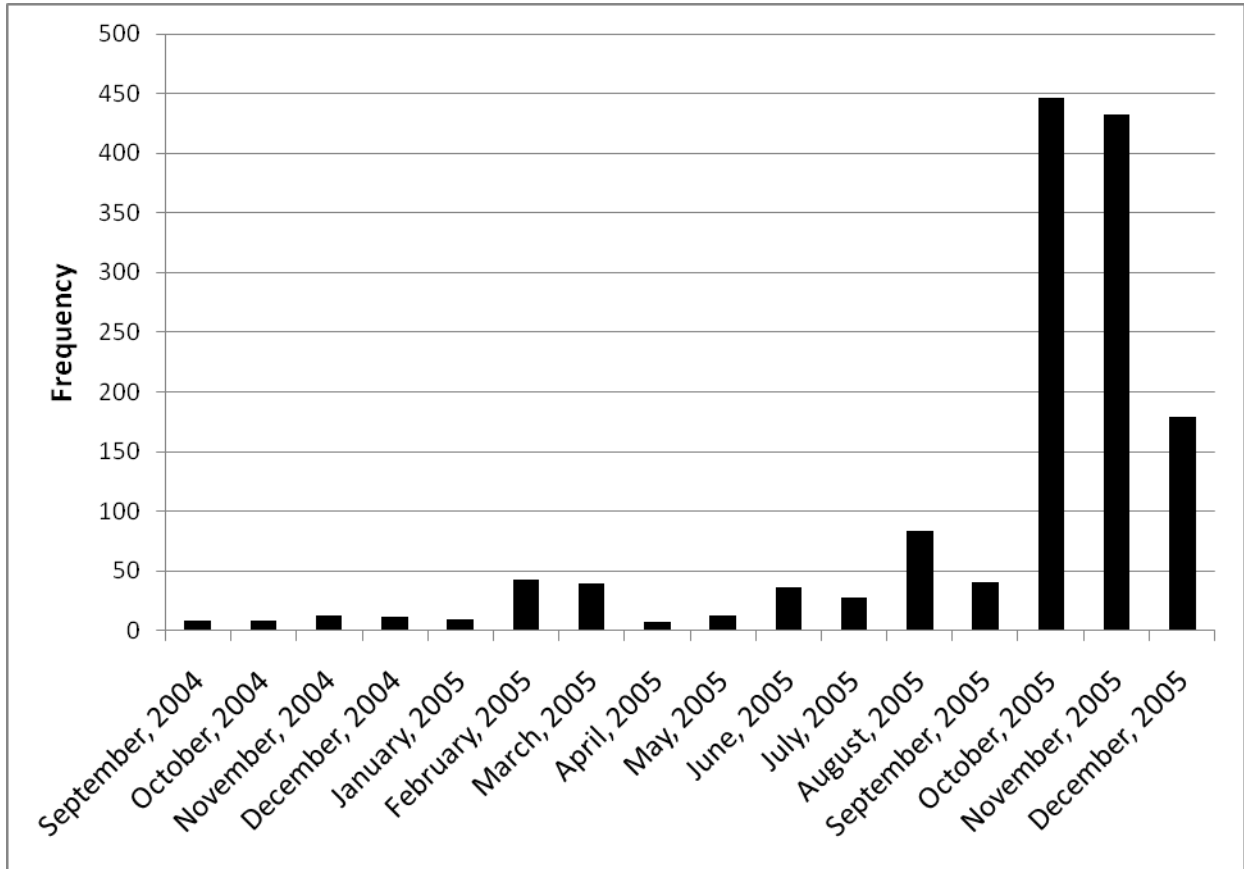


Figure 3. Number of times "avian flu" mentioned in U.S. news sources as tallied on Lexis-Nexis



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