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The Psychology of Protective Behavior

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J. Safety Research
in press.

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Abstract

What determines whether people will protect themselves against the severe losses that might arise from some low-probability hazard? What factors underlie the perception and acceptability of technological risks? The answers to questions such as these are vital for understanding how people cope with threats from accidents, diseases, and natural hazards and for helping them manage their lives more effectively in the face of such risks. This paper illustrates the role that the psychological study of judgment and decision processes can play in providing answers to these questions. Recent experiments studying insurance decisions, risk perceptions, and the evaluation of technological risks are described along with the implications of this research for matters of public safety.

The Psychology of Protective Behavior[1]

This paper presents a brief overview of recent research on the psychology of protective behavior. In particular, this research is concerned with questions such as:

1. What determines whether people will protect themselves against the severe losses that might arise from some rare hazard?

2. What factors underlie the perception and acceptability of risks from technology?

The answers to questions such as these are vital for understanding how people cope with threats from accidents, diseases, and natural hazards and for helping them manage their lives more effectively in the face of such risks. The role that the study of judgment and decision processes can play in providing answers to these questions will be explored in this paper. Recent experiments studying insurance decisions, risk perception, and evaluation of technological risks will be described along with the implications of this research for matters of public safety.

Insurance Decisions

The first topic to be discussed deals with insurance behavior. In light of the tremendous importance of insurance as a protective mechanism, it is remarkable how little research has been done on the psychology of insurance-purchasing decisions. The research described below was stimulated by the observation that it was difficult to induce residents of flood and earthquake areas to purchase insurance against those hazards, even when

90% of the premium was subsidized by the government (see Kunreuther, Ginsberg, Miller, Sagi, Slovic, Borkin, & Katz, 1978). As a result, we conducted a series of insurance experiments, reported in detail in Slovic, Fischhoff, Lichtenstein, Corrigan & Combs (1977).

One reason for lack of research on insurance decision making is that it is difficult to create a laboratory situation analogous to that faced in real-life settings. For example, while it is not difficult to create events with probabilities comparable to various natural hazards, simulating the loss of a home or business is another matter. Certainly, it is immoral for an experimenter to threaten a subject's economic well-being, even in return for a substantial reward for engaging in risk; it also would be improper to exploit an existing risk situation for the sake of scientific knowledge (e.g., willfully manipulating the policies offered to subjects living in hazard-prone areas).

To counter these difficulties, we created an elaborate farm-management simulation run by a computer. We brought people into our laboratory and had them play the role of a farmer who had many decisions to make each year--about crops, fertilizers, and also insurance. Our subjects were instructed as follows:

> Farming is a business that requires decisions. In this game, the number of decisions has been reduced considerably from the number that must be made on a real farm; however, the principles are the same. The decisions you will make at the beginning of each play year are: (1) what crops you are going to plant; (2) what and how much fertilizer you will purchase and apply to those crops; and (3) what insurance you will buy, if any, against certain natural hazards.

Participants played the game for 15 rounds, each round representing one year. Their income for each year was determined by the wisdom of their decisions, by random fluctuations in crop yield and market price, and by the randomly determined occurrences of the natural hazards. At the beginning of the game, each subject was given a 240-acre farm with a permanent concrete pipe irrigation system, a variety of farm equipment, and $80,000 of debt, leaving an initial net worth of about $200,000. The instructions, which took one to one and a half hours to complete, described the characteristics of the seven crops available (mean yield per acre, standard deviation of yield, mean and standard deviation of market price), the efficacy of two types of fertilizer for each crop, the fixed costs of growing each crop (machinery, labor and water), and the risks they faced from natural hazards. For each of the 15 rounds, the subjects' decisions were entered into a computer, which then prepared a year-end report. This report showed the subjects' previous financial situation, farm production results (yield and market price), hazards incurred, yearly expenses, and a year-end list of assets and debts. In some versions of this game, subjects' earnings after 15 years of farming were converted to salary. They were paid between $2.50 and $20 depending on their final net worth.

Table 1 shows the natural hazards faced by the subjects. The hazards were left unnamed, to render irrelevant any particular knowledge or beliefs subjects might have had about the probabilities or losses associated with real hazards such as hail or hurricanes. This decision afforded control over the perceived probability of each hazard. Note that as the probability of loss decreased, the amount of loss increased proportionately. Losses and premiums were established so that (a) the largest loss equalled or exceeded the value of the farm, thus ending the game should the largest loss be incurred; and (b) the cost of the premium would be significant. The average subject's net profit was approximately $6,000 per year. Thus, the purchase of insurance, at $500 per hazard, was a significant expense.

Insert Table 1 about here

The results of the first year of farming, as shown by Figure 1, are typical of what we found in several different experiments, including some which used the farm simulation and others which used a different type of risk setting. They indicate that people were more likely to insure against higher-probability, low-loss hazards rather than against the lower-probability, high-loss hazards. This result runs contrary to economic theory which asserts that insurance should be purchased to protect oneself against losses too great to bear and should not be purchased against relatively small losses that can be paid out of pocket should they occur. However, the behavior in our experiment makes a certain intuitive sense. People prefer to protect themselves against hazards that are relatively likely to happen. There are only so many things in life one can worry about. If people did not ignore low-probability threats, they would spend their entire lives obsessively protecting themselves against a "Pandora's Box" of rare horrors. The popularity of low deductible insurance plans (Fuchs, 1977; Pashigian, Schkade & Menefee, 1966; Schoemaker, 1977) and appliance service contracts provides confirmation outside the laboratory of the preference for insuring against high-probability events with lesser consequences.

Insert Figure 1 about here

Seat belts. Another form of insurance that people do not often use is the automobile seat belt. Promotional efforts to get motorists to wear seat belts have failed dismally (Robertson, 1976). In the wake of expensive advertising campaigns and buzzer systems, fewer than 30% of all motorists "buckle up for safety."

Perhaps the insurance studies can provide some insight into this problem. We have calculated that only about 1 in every 3.5 million automobile trips ends with a fatal accident. With the odds so strongly against an accident on any single trip, it should not be surprising that drivers do not take the trouble to buckle their seat belts. We speculate (see Slovic, Fischhoff & Lichtenstein, 1977a) that repeated benign experience leads eventually to a habit of neglecting the belts, for much the same reasons that subjects in our insurance studies failed to protect themselves against rare hazards.

The extremely low probability of an accident on a single trip makes it unlikely that more than a few individuals will ever use seat belts voluntarily. However, one device that succeeded in inducing insurance against the rarest hazards in our insurance experiments may also work for seat belts. If we can get people to change their perspective from that of a single trip and to consider the risk of serious accident aggregated over a longer time period--say a lifetime of driving--the accident probabilities then may be high enough to induce a general policy of always buckling up.

Perceived Frequency of Lethal Events

The next topic is concerned with perceived risk and, in particular, a special type of phenomenon called "availability bias" that tends to distort people's perceptions.

When we make a judgment about the probability or frequency of some event, we often base our judgment on the ease with which we can imagine that event happening or on the ease with which we can recall past instances of that event (Tverksy & Kähneman, 1974).

In general, use of availability cues (memorability, imaginability) is a good mental strategy. Instances of frequent events are usually more easily recalled than instances of infrequent events, and likely occurrences are easier to imagine than unlikely ones. Thus, availability is often an appropriate cue for judging frequency and probability. Unfortunately, availability is also affected by factors unrelated to likelihood, such as recency, vividness, and emotional salience. Reliance on availability may lead to overestimating the probability of events which are unusually memorable or imaginable.

Availability helps explain many distortions in people's perceptions of risk. Consider fears about grizzly bear attacks in the national parks. Although many people are concerned about the dangerousness of grizzlies, the rate of injury is only 1 per 2 million visitors and the rate of death is even lower (Herrero, 1970). Sensational media reports contribute to the imaginability of death at the claws of an enraged grizzly but the media ignore the multitude of favorable public experiences. The motion picture, "Jaws," has done a similar service for the availability (and perceived likelihood) of shark attacks. Some nuclear power proponents feel that the risks of that technology are exaggerated in the public's eye because of biased media coverage and association with the vivid, imaginable, memorable dangers of nuclear war. As Zebroski (1976) notes, "fear sells;" the media dwell on potential catastrophes, not on the successful day-to-day operations of a power plant.

Availability bias is illustrated in a recent investigation of how people perceive low-probability, high-consequence events (Lichtenstein, Slovic, Fischhoff, Layman & Combs, 1978). The events were 41 causes of death, including diseases, accidents, homicide, suicide, and natural hazards (see Table 2). A large group of college students and members of the local League of Women Voters were asked to judge the frequencies of these events. In one study, they were given pairs of events and asked, "Which of these two events is a more frequent cause of death and how many times more frequent is it?" In another study, they were told a frequency for one item (e.g., electrocution = 1000 deaths a year) and asked to estimate frequencies for the other 40 causes accordingly. The results indicated serious misjudgments of frequency for many of the causes of death as shown in Table 3 for the paired comparison study and Figure 2 for the estimation study. Of special interest in Table 3 is the overestimation of homicide relative to suicide (Pair 4) and the overestimation of accident frequencies (Pairs, 7, 10, 13). Thus we see, for example, that although diseases take 15.5 times as many lives as accidents, (Pair 13), only 57% of these subjects accurately indicated the more frequent cause and the mean ratio was only 1.62. Table 4 lists the lethal events most overestimated and underestimated in our various studies. Overestimated items tended to be dramatic, sensational events which receive heavy media coverage. Unspectacular events that take one victim at a time and are common in non-fatal form (e.g., asthma, emphysema, diabetes) tended to be underestimated. A later study showed that these biases in perception could be predicted moderately well both from the amount of coverage devoted to each cause in the local newspaper and from people's personal experiences with these causes.

Insert Figure 2 and Tables 2, 3 and 4 about here

This study indicates that we cannot assume that intelligent citizens have valid perceptions about the frequency of hazardous events to which they are exposed. To the extent that appropriate societal response to hazards depends upon the veridicality of citizens' perceptions of these hazards, the present study points to a need for improved public education.

Fault-tree biases. There are many hazards so new and so rare that there is a deficiency of statistical data from which to estimate their risks. For these hazards, we often resort to fault-trees, such as the one in Figure 3, as tools for estimating failure probabilities. A fault tree lists pathways to disaster. Figure 3 shows that a disastrous release of radiation from a salt storage repository can occur in three different ways (meteorite or weapon impact, groundwater transportation, or volcanic activity) one of which, groundwater transportation, can occur via six different pathways.

Insert Figure 3 about here

When fault trees are used to communicate hazard potential, availability bias, stemming from the effects of memorability and imaginability on perceptions of risk, may pose a barrier to open, objective discussions of safety. Imagine an engineer explaining the basis for the estimated safety of waste disposal in a salt mine by outlining the fault tree upon which the estimate was based. Rather than reassuring the audience, the presentation might have the opposite effect ("I didn't realize there were that many things that could go wrong"). Perhaps the very discussion of any low-probability hazard will increase the perceived probability of that hazard regardless of what the evidence indicates. As one frustrated nuclear proponent lamented, "When laymen discuss what might happen, they sometimes don't even bother to include the 'might'" (B. Cohen, 1974, p. 36). If public debates and communications from experts do little to allay fears and indeed, exacerbate them, how can we insure democratic freedoms and meaningful public participation in decisions involving rare but extreme threats?

Even for more common, less extreme hazards, perceptions may be biased by aspects of fault-tree presentation. A study by Fischhoff, Slovic and Lichtenstein (1977) found that people are sometimes quite insensitive to how much has been left out of a fault tree. Using a fault tree to describe the determinants of starting failures in an automobile, Fischhoff et al found that deleting branches responsible for about 50% of all failures only produced a 7% increase in people's estimate of how much was missing. Experienced mechanics were about as insensitive as non-experts. Apparently, what was out of sight was also out of mind. The fault tree presenter who, deliberately or inadvertently, fails to mention a branch may remove it completely from consideration. This study also found that the perceived importance of a set of problem pathways could be substantially increased by presenting it as two (smaller) problem branches rather than as one branch (e.g., splitting "fuel system problems" into "fuel problems" and "carburetion problems" when describing automobile starting failures).

The fact that subtle differences in how risks are presented can have big effects on how they are perceived suggests that people who present risks to the public have considerable ability to manipulate perceptions. Indeed, since these effects are not widely known, people may inadvertently be manipulating their own perceptions by casual decisions they make about how to organize their knowledge.

How Safe Is Safe Enough?

Determining the acceptability of risks in society is a particularly important and difficult problem. When "weighing the benefits against the risks" of technology, the ultimate question policy makers must answer is: "Is this technology acceptably safe?" Or, alternatively, "How safe is safe enough?"

We need to develop a model of risk acceptance that would be useful to systems designers and policy makers. Such a model whould not dictate what risks society should accept, but instead, should reflect the public's <u>considered</u> values and preferences.

There are several basic ways to determine the social values that should comprise a model of acceptable risk. Two methods discussed below are based on what are known as <u>revealed</u> and <u>expressed</u> preferences.

<u>Revealed preferences</u>. The revealed preference method advocated by Chauncey Starr (1969) assumes that, by trial and error, society has arrived at a nearly optimal balance between the risks and benefits associated with any activity. Therefore, one may use economic data to reveal patterns of acceptable risk-benefit tradeoffs. Acceptable risk for a new technology would be the level of safety associated with ongoing activities having similar benefit to society. Starr derived what may be regarded as "laws of acceptable risk" from this approach. These included (1) the acceptability of risk is proportional to the magnitude of the benefits derived from the activity in question, and (2) the public is willing to accept much greater risks from voluntary activities (e.g.,

skiing) than it would tolerate from involuntary activities (e.g., food preservatives) that provide the same level of benefit. Thus we see that Starr's model has two basic components, benefit and voluntariness, as schematized in Figure 4a.

Insert Figure 4 about here

The method of revealed preferences is attractive because it is grounded in the possible (i.e., in reality); it apparently reflects stable relationships; and it incorporates in some way the impacts of a wide range of economic factors (not just those known by the participant in an expressed preference survey). However, it has several drawbacks: in a world where values may change quite rapidly, it assumes that past behavior is a valid indicator of present preferences; politically, it is quite conservative in that it enshrines current economic and social arrangements; it assumes that what has been traditionally acceptable is also best for society; it makes strong (and not always supported) assumptions about the rationality of people's decision making; it may be unresponsive to particular kinds of risks, like those with a long lead time (e.g., most carcinogens) with regard to which the market responds sluggishly; finally, it is far from trivial to develop the measures of risks and benefits that are needed for its implementation (Otway & Cohen, 1975).

Expressed preferences. The most straightforward method for determining what people find acceptable is to ask them to express their preferences directly. The appeal of the expressed preference method is obvious. It elicits current preferences, thus being responsive to changing values. It also allows for widespread citizen involvement in decision making and thus should be politically acceptable. It has, however, some possible drawbacks which seem to have greatly restricted its use. Among them are: people may not really know what they want; their attitudes and behavior may be inconsistent, different ways of phrasing the same question may elicit different preferences; values may change so rapidly as to make systematic planning impossible; people may not understand how their preferences will translate into policy; and people may want things that are unobtainable in reality.

Fischhoff, Slovic, Lichtenstein, Read & Combs (in press) have recently used the method of expressed preferences to replicate and extend Starr's work. In one study, people were asked to rate the risks and benefits accruing to society from each of thirty activities and technologies. The results indicated that people believed that more beneficial activities should have higher risk levels, and that a double standard existed for voluntariness, as in Figure 4a. That is, acceptable risk levels were higher for voluntary activities than for involuntary activities providing the same level of benefit, a result congruent with that Starr observed. However, other characteristics of risk, such as the degree to which the risk seems controllable, familiar, known and immediate, also were found to induce double standards, as schematized in Figures 4b-4e. Additional results indicated that the degree to which an acitivity's risk was potentially catastrophic, dread, and likely to be fatal (given a mishap) also influenced acceptability. Thus, this study implies that a method of determining acceptable risk may need to give weight to all of these various characteristics. Consideration of these characteristics made acceptability of a risk highly predictable. Conceivably, policy makers might be able to use such information to predict public acceptance of the risk levels associated with proposed technologies.

Summary and Conclusions

This review has summarized recent psychological research on the topic of perceived and acceptable risk. Such research demonstrates that management of hazards needs to be based on an understanding of the ways in which people think about risk and uncertainty. Without such understanding, well-intended plans may not achieve their goals. Although research on the perception and evaluation of hazards has been rather neglected, there does exist a core of knowledge relevant to problems of safety.

One important finding comes from research on insurance behavior, which shows that people prefer to insure themselves against relatively high-probability hazards, rather than the rare, serious threats for which the mechanism of insurance was designed. This research hints that probability of loss or damage may be the dominant stimulus to protective action, a hypothesis that needs to be studied further. One implication of this hypothesis, regarding the non-use of seat belts, was discussed here.

A second stream of research described above demonstrates that, because of the way the mind works when people are asked to judge frequencies or probabilities, perceived risk tends to be distorted by imaginability and memorability of the hazard. Additional research not described here documents startling degrees of overconfidence, hindsight biases, and other intellectual quirks that could have important implications for safety. Research on the broad spectrum of difficulties people experience when thinking about risk is summarized by Tversky and Kahneman (1974) and Slovic, Fischhoff and Lichtenstein (1977).

The third project reviewed above demonstrated that it was possible to ask people for complex judgments about their attitudes towards risks and receive orderly, interpretable responses that provided insight into the question "How safe is safe enough?" In general, people expressed a willingness to tolerate greater risks from activities that provide greater benefits. However, the level of acceptable risk was influenced strongly by other characteristics of the activity, such as the degree to which its risks are voluntary, controllable, understood, familiar, dread, catastrophic, etc. Research currently in progress is attempting to expand these results into a quantitative model of risk acceptability that could enable systems designers and policy makers to be more responsive to people's preferences.

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Footnote

1. This paper was presented at the 65th National Safety Congress and Exposition, Chicago, Illinois, October 20, 1977. Sponsorship of this work comes in part from the National Science Foundation, Division of Advanced Environmental Research and Technology under contract number ENV77-15332. Any opinions, findings and conclusions or recommendations expressed in this publication are those of the author and do not necessarily reflect the views of the National Science Foundation. The studies described in this paper were done in collaboration with Sarah Lichtenstein, Baruch Fischhoff, Barbara Combs, Bernard Corrigan, and Mark Layman. Howard Kunreuther played an important role in guiding the research on insurance behavior.

Table 1

Farm Game Hazards

Hazard No.	Probability	Loss	Premium
1	.002	$247,500	$500
2	.01	49,500	500
3	.05	9,900	500
4	.10	4,950	500
5	.25	1,980	500

Source: Slovic et al, 1977.

Table 2

Causes of Death and their Statistical Frequencies per 10^8 U.S. Residents per Year

	Rate/10^8		Rate/10^8
Smallpox	0	Firearm accident	1,100
Poisoning by vitamins	.5	Poisoning by solid or liquid	1,250
Botulism	1	Tuberculosis	1,800
Measles	2.4	Fire & flames	3,600
Fireworks	3	Drowning	3,600
Smallpox vaccination	4	Leukemia	7,100
Whooping cough	7.2	Accidental falls	8,500
Polio	8.3	Homicide	9,200
Venomous bite or sting	23.5	Emphysema	10,600
Tornado	44	Suicide	12,000
Lightning	52	Breast cancer	15,200
Non-venomous animal	63	Diabetes	19,000
Flood	100	Motor vehicle (car, truck or bus)accident	27,000
Excess cold	163	Lung cancer	37,000
Syphilis	200	Cancer of the digestive system	46,600
Pregnancy, childbirth, and abortion	220	All accidents	55,000
Infectious hepatitis	330	Stroke	102,000
Appendicitis	440	All cancer	160,000
Electrocution	500	Heart disease	360,000
Motor vehicle-train collision	740	All diseases	849,000
Asthma	920		

Source: National Center for Health Statistics and Lichtenstein et al, 1978.

Table 3

Judgments of Relative Frequency for Selected Pairs of Lethal Events

	Less Likely	More Likely	True Ratio	% Correct Discrimination	Geometric Mean of Judged Ratios [a]
1.	Asthma	Firearm Accident	1.20	80	11.00
2.	Breast Cancer	Diabetes	1.25	23	[7.69]
3.	Lung Cancer	Stomach Cancer	1.25	25	[3.23]
4.	Homicide	Suicide	1.30	32	[5.26]
5.	Leukemia	Emphysema	1.49	47	[1.72]
6.	Stroke	All Cancer	1.57	83	21.00
7.	All Accidents	Stroke	1.85	20	[25.00]
8.	Pregnancy	Appendicitis	2.00	17	[10.00]
9.	Tuberculosis	Fire & Flames	2.00	81	10.50
10.	Emphysema	All Accidents	5.19	88	269.00
11.	Polio	Tornado	5.30	71	4.26
12.	Drowning	Suicide	9.60	70	5.50
13.	All Accidents	All Diseases	15.50	57	1.62
14.	Diabetes	Heart Disease	18.90	97	127.00
15.	Tornado	Asthma	20.90	42	[2.98]
16.	Syphilis	Homicide	46.00	86	31.70
17.	Botulism	Lightning	52.00	37	[3.33]
18.	Flood	Homicide	92.00	91	81.70
19.	Syphilis	Diabetes	95.00	64	2.36
20.	Botulism	Asthma	920.00	59	1.50
21.	Excess Cold	All Cancer	982.00	95	1490.00
22.	Botulism	Emphysema	10,600.00	86	24.00

[a] Geometric means in brackets indicate that the mean ratio was higher for the less likely event. A geometric mean of [5.00] implies the mean was 5:1 in the wrong direction.

Source: Lichtenstein et al, 1978.

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Table 4

BIAS IN PERCEIVED FREQUENCY

MOST OVERESTIMATED	MOST UNDERESTIMATED
1. ALL ACCIDENTS	1. SMALLPOX VACCINATION
2. MOTOR VEHICLE ACCIDENTS	2. DIABETES
3. PREGNANCY, CHILDBIRTH, ABORTION	3. STOMACH CANCER
4. TORNADO	4. LIGHTNING
5. FLOOD	5. STROKE
6. BOTULISM	6. TUBERCULOSIS
7. ALL CANCER	7. ASTHMA
8. FIRE AND FLAMES	8. EMPHYSEMA
9. VENOMOUS BITE OR STING	
10. HOMICIDE	