

INFORMING AND EDUCATING THE PUBLIC ABOUT RISK

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ABSTRACT

The objective of informing and educating the public about risk issues seems easy to attain in principle, but, in practice, may be difficult to accomplish. This paper attempts to illustrate why this is so. To be effective, risk communicators must recognize and overcome a number of obstacles that have their roots in the limitations of scientific risk assessment and the idiosyncracies of the human mind. Doing an adequate job of communicating means finding comprehensible ways of presenting complex technical material that is clouded by uncertainty and inherently difficult to understand. The problems may not be insurmountable, however, if designers of risk information programs are sensitive to the difficulties.

Key words: risk communication, risk perception, risk management, risk information

Risk Analysis, in press.

To effectively manage . . . risk, we must seek new ways to involve the public in the decision-making process . . . They [the public] need to become involved early, and they need to be informed if their participation is to be meaningful."

(William Ruckelshaus, 1983, p. 1028)

1. INTRODUCTION

In a bold and insightful speech before the National Academy of Sciences at the beginning of his second term as EPA administrator, William Ruckelshaus called for a government-wide process for managing risks that thoroughly involved the public. Arguing that government must accommodate the will of the people he quoted Thomas Jefferson's famous dictum to the effect that,

"If we think (the people) not enlightened enough to exercise their control with a wholesome discretion, the remedy is not to take it from them, but to inform their discretion."

Midway into his tenure as EPA administrator, Ruckelshaus' experiences in attempting to implement Jefferson's philosophy led him to a more sober evaluation:

"Easy for him to say. As we have seen, informing discretion about risk has itself a high risk of failure"

(Ruckelshaus, 1984, p. 160).

This paper attempts to illustrate why the goal of informing the public about risk issues, which seems easy to attain in principle, is surprisingly difficult to accomplish. To be effective, risk communicators must recognize and overcome a number of obstacles that have their roots in the limitations of scientific risk assessment and the idiosyncrasies of the human mind. Doing an adequate job of communicating means finding comprehensible ways of presenting complex technical material that is clouded by uncertainty and inherently

difficult to understand. Awareness of the difficulties should enhance the chances of designing successful informational programs.

2. LIMITATIONS OF RISK ASSESSMENT

Risk assessment is a complex discipline, not fully understood by its practitioners, much less the lay public. At the technical level, there is still much debate over terminology and techniques. Technical limitations and disagreements among experts inevitably affect communication in the adversarial climate that surrounds many risk issues. Risk communicators must be fully aware of the strengths and limits of the methods used to generate the information they are attempting to convey to the public. In particular, communicators need to understand that risk assessments are constructed from theoretical models which are based on assumptions and subjective judgments. If these assumptions and judgments are deficient, the resulting assessments may be quite inaccurate.

Nowhere are these problems more evident than in the assessment of chronic health effects due to low-level exposures to toxic chemicals and radiation. The typical assessment uses studies of animals exposed (relatively briefly) to extremely high doses of the substance to draw inferences about the risks to humans exposed to very low doses (sometimes over long periods of time). The models designed to extrapolate the results from animals to humans and from high doses to low doses are controversial. For example, some critics have argued that mice may be from 3×10^4 to 10^9 times more cancer prone than humans (Gori, 1980). Different models for extrapolating from high-dose exposures to low doses produce estimated cancer rates that can differ by

factors of 1000 or more at the expected levels of human exposures (which themselves are often subject to a great deal of uncertainty).

Difficulties in estimating synergistic effects (interactions between two or more substances, such as occur between cigarette smoking and exposure to asbestos) and effects on particularly sensitive people (e.g. children, pregnant women, the elderly) further compound the problems of risk assessment. In light of these various uncertainties, one expert concluded that "Discouraging as it may seem, it is not plausible that animal carcinogenesis experiments can be improved to the point where quantitative generalizations about human risk can be drawn from them" (Gori, 1980; p. 259).

In the adversarial climate of risk discussions, these limitations of assessment are brought forth to discredit quantitative risk estimates. To be credible and trustworthy, a communicator must know enough to acknowledge valid criticisms and to discern whether the available risk estimates are valid enough to have value for helping the public gain perspective on the dangers they face and the decisions that must be made. On the positive side, there are some hazards (e.g., radiation, asbestos) whose risks are relatively well understood. Moreover, for many other hazards, risk estimates are based on a chain of conservative decisions at each choice point in the analysis (e.g. studying the most sensitive species, using the extrapolation model that produces the highest risk estimate, giving benign tumors the same weight as malignant ones, etc). Despite the uncertainties, one may have great confidence that the "true risk" is unlikely to exceed the estimate resulting from such a conservative process. In other words, uncertainty and

subjectivity do not imply chaos. Communicators must know when this point is relevant and how to make it when it applies.

Parallel problems exist in engineering risk assessments designed to estimate the probability and severity of rare, high-consequence accidents in complex systems such as nuclear reactors or LNG plants. The risk estimates are devised from theoretical models (in this case fault-trees or event trees) that attempt to depict all possible accident sequences and their (judged) probabilities. Limitations in the quality or comprehensiveness of the analysis, the quality of the judged risks for individual sequences, or improper rules for combining estimates, can seriously compromise the validity of the assessment.

3. LIMITATIONS OF PUBLIC UNDERSTANDING

Just as they must understand the strengths and limitations of risk assessment, communicators must appreciate the wisdom and folly in public attitudes and perceptions. Among the important research findings and conclusions are the following:

3.1. People's perceptions of risk are often inaccurate

Risk judgments are influenced by the memorability of past events and the imaginability of future events. As a result, any factor that makes a hazard unusually memorable or imaginable, such as a recent disaster, heavy media coverage, or a vivid film, could seriously distort perceptions of risk. In particular, studies by Lichtenstein, Slovic, Fischhoff, Layman, & Combs (1978), Morgan et al. (in press), and others have found that risks from dramatic or sensational causes of death, such as accidents, homicides, cancer, and natural disasters, tend to be greatly overestimated. Risks from undramatic causes such as asthma,

emphysema, and diabetes, which take one life at a time and are common in non-fatal form, tend to be underestimated. News media coverage of hazards has been found to be biased in much the same direction, thus contributing to the difficulties of obtaining a proper perspective on risks (Combs & Slovic, 1978).

3.2. Risk information may frighten and frustrate the public

The fact that perceptions of risk are often inaccurate points to the need for warnings and educational programs. However, to the extent that misperceptions are due to reliance on imaginability as a cue for riskiness, such programs may run into trouble. Merely mentioning possible adverse consequences (no matter how rare) of some product or activity could enhance their perceived likelihood and make them appear more frightening. Anecdotal observation of attempts to inform people about recombinant DNA hazards supports this hypothesis (Rosenburg, 1978) as does a controlled study by Morgan et al. (1985). In the latter study people's judgments of the risks from high voltage transmission lines were assessed before and after they read a brief and rather neutral description of findings from studies of possible health effects due to such lines. The results clearly indicated a shift toward greater concern in three separate groups of subjects exposed to the description. Whereas mere mention and refutation of potential risks raises concerns, the use of conservative assumptions and "worst case scenarios" in risk assessment creates extreme negative reactions in people because of the difficulty of appreciating the improbability of such extreme but imaginable consequences. The possibility that imaginability may blur the distinction between what is (remotely) possible and what is probable

obviously poses a serious obstacle to risk information programs.

Other psychological research shows that people may have great difficulty making decisions about gambles when they are forced to resolve conflicts generated by the possibility of experiencing both gains and losses, and uncertain ones at that (Slovic 1982; Slovic & Lichtenstein, 1983). As a result, wherever possible, people attempt to reduce the anxiety generated in the face of uncertainty by denying that uncertainty, thus making the risk seem either so small that it can safely be ignored or so large that it clearly should be avoided. They rebel against being given statements of probability, rather than fact; they want to know exactly what will happen.

Given a choice, people would rather not have to confront the gambles inherent in life's dangerous activities. They would prefer being told that risks are managed by competent professionals and are thus so small that one need not worry about them. However, if such assurances cannot be given, they will want to be informed of the risks, even though doing so might make them feel anxious and conflicted (Alfidi 1971; Fischhoff 1983; Weinstein 1979).

3.3. Strong beliefs are hard to modify

It would be comforting to believe that polarized positions would respond to informational and educational programs. Unfortunately, psychological research demonstrates that people's beliefs change slowly and are extraordinarily persistent in the face of contrary evidence (Nisbett & Ross, 1980). Once formed, initial impressions tend to structure the way that subsequent evidence is interpreted. New evidence appears reliable and informative if it is consistent with one's initial

belief; contrary evidence is dismissed as unreliable, erroneous, or unrepresentative.

3.4. Naive views are easily manipulated by presentation format

When people lack strong prior opinions, the opposite situation exists--they are at the mercy of the way that the information is presented. Subtle changes in the way that risks are expressed can have a major impact on perceptions and decisions. One dramatic recent example of this comes from a study by McNeil, Pauker, Sox, and Tversky (1982), who asked people to imagine that they had lung cancer and had to choose between two therapies, surgery or radiation. The two therapies were described in some detail. Then, some subjects were presented with the cumulative probabilities of surviving for varying lengths of time after the treatment. Other subjects received the same cumulative probabilities framed in terms of dying rather than surviving (e.g., instead of being told that 68% of those having surgery will have survived after one year, they were told that 32% will have died). Framing the statistics in terms of dying dropped the percentage of subjects choosing radiation therapy over surgery from 44% to 18%. The effect was as strong for physicians as for laypersons.

Numerous other examples of "framing effects" have been demonstrated by Tversky & Kahneman (1981) and Slovic, Fischhoff & Lichtenstein (1982). The fact that subtle differences in how risks are presented can have such marked effects suggests that those responsible for information programs have considerable ability to manipulate perceptions and behavior. This possibility raises ethical problems that must be addressed by any responsible risk-information program.

4. PLACING RISKS IN PERSPECTIVE

4.1. Choosing risk measures

When we know enough to be able to describe risks quantitatively, we face a wide choice of options regarding the specific measures and statistics used to describe the magnitude of risk. Fischhoff, Lichtenstein, Slovic, Derby, & Keeney (1981) point out that choosing a risk measure involves several steps: (a) defining the hazard category; (b) deciding what consequences to measure (or report); and (c) determining the unit of observation. The way the hazard category is defined can have a major effect on risk statistics.

Crouch and Wilson (1982) provide some specific examples of how different measures of the same risk can sometimes give quite different impressions. For example, they show that accidental deaths per million tons of coal mined in the U. S. have decreased steadily over time. In this respect, the industry is getting safer. However, they also show that the rate of accidental deaths per 1,000 coal mine employees has increased. Neither measure is the "right" measure of mining risk. They each tell part of the same story.

The problem of selecting measures is made even more complicated by the framing effects described earlier. Thus not only do different measures of the same hazard give different impressions, the same measures, differing only in (presumably) inconsequential ways, can lead to vastly different perceptions.

Sharlin's case study of the communication of information about the risks of the pesticide, ethylene dibromide (EDB), points to an important distinction between macro and micro measures of risk (Sharlin, 1985).

The Environmental Protection Agency, which was responsible for regulating EDB, broadcast information about the aggregate risk of this pesticide to the exposed population. While the media accurately transmitted this macro analysis, newspaper editorials and public reaction clearly indicated an inability to translate this into a micro perspective on the risk to the exposed individual. In other words, the newspaper reader or TV viewer had trouble inferring an answer to the question, "Can I eat the bread?" from the aggregate risk analysis.

4.2. Basic statistical presentations

In this section, we shall describe a few of the statistical displays most often used to educate people about general and specific risks. We don't mean to endorse these presentations as optimal. They simply represent the favored formats of statisticians and risk assessors.¹ To date, there has been little systematic effort to develop and test methods for maximizing clarity and understanding of quantitative risk estimates. As a result, we know of no "magic displays" that guarantee understanding and appreciation of the described risks at the "micro level."

¹ We make no attempt to defend the validity of the statistics presented in this section. We take them directly from various published studies. Earlier in this section we pointed out the problems that one must be aware of when using and interpreting risk data.

Among the few "principles" in this field that seem to be useful is the assertion that comparisons are more meaningful than absolute numbers or probabilities, especially when these absolute values are quite small. Sowby (1965) argued that to decide whether or not we are responding adequately to radiation risks we need to compare them to "some of the other risks of life" and Rothschild (1979) observed "There is no point in getting into a panic about the risks of life until you have compared the risks which worry you with those that don't, but perhaps should."

Familiarity with annual mortality risks for the population as a whole or as a function of age may provide one standard for evaluating specific risks. Sowby (1965) took advantage of such data to observe that one hour riding a motorcycle was as risky as one hour of being 75 years old. Table 1 provides annual mortality rates from a wide variety of causes.

Insert Table 1 about here

Mortality rates fail to capture the fact that some hazards (e.g. pregnancy, motorcycle accidents) cause death at a much earlier age than others (e.g. lung cancer due to smoking). One way to provide perspective on this consideration is to calculate the average loss of life expectancy due to the exposure to the hazard, based on the distribution of deaths as a function of age. Some estimates of loss of life expectancy from various causes are shown in Table 2.

Insert Table 2 about here

Yet another innovative way to gain perspective was devised by Wilson (1979), who displayed a set of activities (Table 3), each of which was estimated to increase one's chance of death (during any year) by one in a million.

Insert Table 3 about here

Comparisons within lists of risks such as those in Tables 1, 2, and 3 have been advocated not just to gain some perspective on risks but as guides to decision making. Thus Cohen and Lee (1979) argued that "to some approximation, the ordering (in Table 2) should be society's order of priorities" and Wilson (1979) claimed that the comparisons in Table 3 ". . . help me evaluate risk and I imagine that they may help others to do so, as well. But the most important use of these comparisons must be to help the decisions we make, as a nation, to improve our health and reduce our accident rate." However, Slovic, Fischhoff & Lichtenstein (1980a), argued that such claims could not be logically defended. Although carefully prepared lists of risk statistics can provide some degree of insight, they provide only a small part of the information needed for decision making. As a minimum, inputs to decision making should include a detailed account of the costs and benefits of the available options, as well as an indication of the uncertainty in these assessments. As we have seen, uncertainties in risk estimates are often

quite large. Failure to indicate uncertainty not only deprives the recipient of information needed for decision making, it spawns distrust and rejection of the analysis.

Some hazards, such as radiation, are present in nature and in many commonplace activities. For these hazards, comparisons of "non-natural" exposures (e.g., medical x-rays) with the natural or "everyday" exposures may prove instructive.

5. BEYOND NUMBERS: A BROADER PERSPECTIVE ON RISK PERCEPTION AND COMMUNICATION

A stranger in a foreign land would hardly expect to communicate effectively with the natives without knowing something about their language and culture. Yet risk assessors and risk managers have often tried to communicate with the public under the assumption that they and the public share a common conceptual and cultural heritage in the domain of risk. That assumption is false and has led to failures of communication and rancorous conflicts.

5.1 The psychometric paradigm

Evidence against the "commonality assumption" comes from sociological, psychological and anthropological studies directed at understanding the determinants of people's risk perceptions and behaviors. In psychology, research within what has been called the "psychometric paradigm" has explored the ability of psychophysical scaling methods and multivariate analysis to produce meaningful representations of risk attitudes and perceptions (see, for example, Brown & Green, 1980; Gardner et al., 1982; Green, 1980; Green & Brown, 1980; Johnson & Tversky, in press; Lindell & Earle, 1982; Macgill, 1982;

Renn, 1981; Slovic, Fischhoff, & Lichtenstein, 1980b, 1984; Vlek & Stallen, 1981; von Winterfeldt et al., 1981).

Researchers employing the psychometric paradigm have typically asked people to judge the current riskiness (or safety) of diverse sets of hazardous activities, substances, and technologies, and to indicate their desires for risk reduction and regulation of these hazards. These global judgments have then been related to judgements about the hazard's status on various qualitative characteristics of risk, some of which are shown in Table 4.

Insert Table 4 about here

Among the generalizations that have been drawn from the results of the early studies in this area are the following:

- (1) Perceived risk is quantifiable and predictable. Psychometric techniques seem well suited for identifying similarities and differences among groups with regard to risk perceptions and attitudes.
- (2) "Risk" means different things to different people. When experts judge risk, their responses correlate highly with technical estimates of annual fatalities. Laypeople can assess annual fatalities if they are asked to (and produce estimates somewhat like the technical estimates). However, their judgments of risk are sensitive to other characteristics as well and, as a result, often differ markedly from experts' assessments of risk. In particular, perception of risk is greater for hazards whose adverse effects are uncontrollable, dread, catastrophic, fatal rather than injurious, not offset by compensating benefits, and

delayed in time so the risks are borne by future generations.

A useful concept that has emerged from this research is the notion that the societal cost of an accident or mishap is determined to an important degree by what it signifies or portends (Slovic, Lichtenstein & Fischhoff, 1984). The informativeness or "signal potential" of a mishap, and thus its potential social impact, appears to be systematically related to the characteristics of the risk. An accident that takes many lives may produce relatively little social disturbance (beyond that caused the victims' families and friends) if it occurs as part of a familiar and well understood system (e.g. a train wreck). However, a small accident in an unfamiliar system (or one perceived as poorly understood), such as a nuclear reactor or a recombinant DNA laboratory, may have immense social consequences if it is perceived as a harbinger of further and possibly catastrophic mishaps.²

5.2. Other paradigms

Other important contributions to our current understanding of risk perception have come from geographers, sociologists, and anthropologists. The geographical research focused originally on

² The concept of accidents as signals was eloquently expressed in an editorial addressing the tragic accident at Bhopal, India: "What truly grips us in these accounts [of disaster] is not so much the numbers as the spectacle of suddenly vanishing competence, of men utterly routed by technology, of fail-safe systems failing with a logic as inexorable as it was once--indeed, right up until that very moment--unforeseeable. And the spectacle haunts us because it seems to carry allegorical import, like the whispery omen of a hovering future" (The New Yorker; February 18, 1985).

understanding human behavior in the face of natural hazards, but it has since broadened to include technological hazards as well (Burton, Kates & White, 1978). The sociological work (Moatti, Stemmeling, & Fagnani, 1984; Mazur, 1984) and the anthropological studies (Douglas & Wildavsky, 1982) have shown that the perceptions of risk that have been identified within the psychometric paradigm may have their roots in social and cultural factors. Mazur argues that, in some instances, response to hazards is caused by social influences transmitted by friends, family, fellow workers and respected public officials. In these cases, risk perception may form afterwards, as part of one's post hoc rationale for his or her behavior. In a similar vein, Douglas and Wildavsky assert that people, acting within social organizations, downplay certain risks and emphasize others as a means of maintaining the viability of the organization.

5.3. Implications for risk communication

Risk perception research has a number of direct implications for communication efforts. Psychometric studies imply that comparative examination of risk statistics, such as those in Tables 1, 2, and 3 will not, by themselves, be adequate guides to personal or public decision policies. Risk perceptions and risk-taking behaviors appear to be determined not only by accident probabilities, annual mortality rates or mean losses of life expectancy, but also by numerous other characteristics of hazards such as uncertainty, controllability, catastrophic potential, equity and threat to future generations. Within the perceptual space defined by these and other characteristics, each hazard is unique. To many persons, statements such as "the annual risk

from living near a nuclear power plant is equivalent to the risk of riding "an extra three miles in an automobile" appear ludicrous because they fail to give adequate consideration to the important differences in the nature of the risks from these two technologies.

Psychometric research indicates that attempts to characterize, compare, and regulate risks must be sensitive to the broader conception of risk that underlies people's concerns. Fischhoff, Watson, & Hope (1984) have made a start in this direction by demonstrating how one might go about constructing a more adequate definition of risk. They advocated characterizing risk by a vector of measures (e.g. mortality, morbidity, concern due to perceived uncertainty, concern due to dread, etc.).

The concept of accidents as signals indicates that, when informed about a particular hazard, people's concerns will generalize beyond the immediate problem to other related hazards. For example, with regard to the EDB scare, one newspaper editor wrote:

"The cumulative effect--the 'body burden count' as scientists call it--is especially worrisome considering the number of other pesticides and carcinogens humans are exposed to."

(The Sunday Star-Bulletin and Advertiser, Honolulu, Feb. 5, 1984)

On the same topic, another editor wrote:

"Let's hope there are no cousins of EDB waiting to ambush us in the months ahead."

(San Francisco Examiner, Feb. 10, 1984)

As a result of this broad (and legitimate) perspective, communications from risk managers pertaining to the risk and control of

a single hazard, no matter how carefully presented, may fail to alleviate people's fears, frustrations, and anger. If people trust the ability of the risk manager to handle the broader risk problems, these general concerns will probably not surface.

Whereas the psychometric research implies that risk debates are not merely about risk statistics, the sociological and anthropological work implies that some of these debates may not even be about risk. Risk may be a rationale for actions taken on other grounds or it may be a surrogate for social or ideological concerns. When this is the case, communication about risk is simply irrelevant to the discussion. Hidden agendas need to be brought to the surface for open discussion, if possible (Edwards & von Winterfeldt, 1984).

Perhaps the most important message from the research done to date, is that there is wisdom as well as error in public attitudes and perceptions. Laypeople sometimes lack certain basic information about hazards. However, their basic conceptualization of risk is much richer than that of the experts and reflects legitimate concerns that are typically omitted from expert risk assessments. As a result, risk communication efforts are destined to fail unless they are structured as a two-way process (Renn, 1984). Each side, expert and public, has something valid to contribute. Each side must respect the insights and intelligence of the other.

6. THE ROLE OF THE NEWS MEDIA IN INFORMING PEOPLE ABOUT RISK

6.1. Critics of the media

The mass media exert a powerful influence on people's perceptions of the world, the world of risk being no exception. Each morning's paper

and each evening's TV newscast seems to include a report on some new danger to our food, water, air, or physical safety. It is not surprising, given the actual and perceived influence of the media and the stakes involved in risk issues, that media coverage of risk has been subjected to intense scrutiny and harsh criticism. Content analysis of media reporting for specific hazards (DNA research, nuclear power, cancer) and the domain of hazards in general (e.g. diseases, causes of death) has documented a great deal of misinformation and distortion (Burger, 1984; Freimuth, Greenberg, DeWitt & Romano, 1984; Combs & Slovic, 1979; Kristiansen, 1983), causing critics such as Cirino (1971) to assert:

"No one can be free from the effects of bias that exist in the mass media . . . Decisions based on distorted views of the world resulting from [such] . . . bias have resulted in tragically mistaken priorities, death and suffering" (p. 31).

More than a few observers have blamed the media for what they see as public over-reaction to risk. Among the most vehement is physicist Bernard Cohen who argued that:

"Journalists have grossly misinformed the American public about the dangers of radiation and of nuclear power with their highly unbalanced treatments and their incorrect or misleading interpretations of scientific information.

"This misinformation is costing our nation thousands of unnecessary deaths and wasting billions of dollars each year" (Cohen, 1983; p. 73).

6.2. In defense of the media

A balanced examination of media performance needs to consider the difficulties faced by the media in reporting risk stories. Journalists operate under many constraints, including tight deadlines, the pressure of competition to be first with a story, and limitations on space or time (for TV reports). But the major difficulty stems from the inherent complexity of risk stories as outlined in the section of this report dealing with the limitations of risk assessment. Because of the technical complexity of the subject matter, journalists must depend on expert sources. But a risk story may involve such diverse problems that the journalist might need to interview specialists in toxicology, epidemiology, economics, hydrology, meteorology, emergency evacuation, etc., not to mention a wide variety of local, state, and federal officials. Even then, there is no assurance of completeness. No one may know what all the pieces are or recognize the limits of their own understanding (Fischhoff, 1985a). Few journalists have the scientific background to sort through and make sense of the welter of complex and often contradictory material that results from such a search.

6.3. Improving media performance

Despite the difficulties, there seem to be a number of actions that might help the media improve its performance in communicating risk information. Some of these actions are professional, others involve research. At the professional level, the following steps may be useful.

Acknowledge the problem. The first step in addressing any deficiency is to recognize it as an important problem. We now know an understanding of risk is central to decisions that are of great

consequence to individuals and to society, that risk and uncertainty are inherently difficult to communicate, and that the media are a dominant source of risk information. The combination of these factors highlights the role of the media as a problem worthy of explicit, sustained attention, in high level meetings between journalists, scientists, and risk managers.

Enhance science writing. Reporters obviously need to be educated in the importance and subtleties of risk stories. Fischhoff (1985) suggests a number of checklists and protocols that a reporter might use as a guide to understanding and clarifying risk issues. One of these, titled "Questions to Ask of Risk Analysis," is shown in Table 5. There should be scholarships to induce students and young journalists to pursue science writing as a profession, accompanied by awards and prizes to recognize and reward good science journalism when it occurs.

Insert Table 5 about here

Develop science news clearinghouses. Science journalists need access to knowledgeable and cooperative scientists. A few organizations, such as the Scientists' Institute for Public Information have performed an important service along this line and some professional societies, such as the American Psychological Association, maintain offices that provide journalists with the names of scientists knowledgeable about specific topics. More needs to be done to help journalists get reliable information about risk topics.

7. RESEARCH DIRECTIONS

Although much progress has been made toward understanding risk attitudes, perceptions and behaviors, we still lack definitive understanding of many important issues relevant to risk communication. Some recommended research directions are described in this section.

7.1. Informed Consent

The right of citizens, patients, and workers to be informed about the hazards to which they are exposed from their daily activities, their medical treatments, and their jobs, provides the motivation behind much of the efforts to communicate information about risks. Within the context of any information program, research is needed to determine what people know and what they want to know about the risks they face and how best to convey that information. Moreover, there is need for a deeper understanding of the concept of consent (MacLean, 1982) as well as for a theory of informed consent that sets out criteria for evaluating the adequacy of information presentations. Fischhoff (1983; 1985b) has made a start in the latter direction by characterizing the problem of informed consent as a decision problem. In this view, the goal of informed consent is to enable the individual to make decisions that are in his or her best interests. Fischhoff points out that there are both cognitive and institutional barriers to achieving informed consent. Research is needed to understand these barriers and overcome them.

To facilitate the process of informed consent, we need better ways to convey quantitative risk information. There is widespread agreement that casting individual risks in terms such as 10^{-x} per year is not helpful to people. We need creative new indices and analogies to help

individuals translate risk estimates varying over many orders of magnitude into simple, intuitively meaningful terms. The task will not be easy. Ideas that appear, at first glance, to be useful, often turn out, upon testing, to make the problem worse. For example, an attempt to convey the smallness of 1 part of toxic substance per billion by drawing an analogy with a crouton in a five ton salad seems likely to enhance one's misperception of the contamination by making it more easily imaginable. The proposal to express very low probabilities in terms of the conjunction of two or more unlikely events (e.g. simultaneously being hit by lightning and struck by a meteorite) also seems unwise in light of experimental data showing that people greatly overestimate the likelihood of conjunctive events. Perhaps we can learn, by studying people's understanding of commonly used measures such as distance, time and speed, whether and how their understanding of quantitative risk can be improved.

The sensitivity of risk communications to framing effects points to another avenue for research. We need a better understanding of the magnitude and generality of these effects. Are people's perceptions really as malleable as early results suggest? If so, how should the communicator cope with this problem? One suggestion is to present information in multiple formats--but does this help or confuse the recipient? Finally, the possibility that there is no neutral way to present information, coupled with the possibility that people's preferences are very easily manipulated, has important ethical and political implications that need to be examined.

Because of the complexity of risk communications and the subtlety of

human response to them, it is extremely difficult, a priori, to know whether a particular message will adequately inform its recipients. Testing of the message provides needed insight into its impacts. In light of the known difficulties of communicating risk information, it could be argued that an informer who puts forth a message without testing its comprehensibility is guilty of negligence. This assertion raises a host of research questions. How does one test a message? How does the communicator judge when a message is good enough in light of the possibility that not all test subjects will interpret it correctly? Can testing be used against the communicator by providing evidence that not everyone understood the message?

Risk is brewed from an equal dose of two ingredients--probabilities and consequences. But most of the attention pertaining to informed consent seems to focus on the probabilities. It is assumed that once the potential consequence is named--lung cancer, leukemia, pneumoconiosis--one need say little else about it. We believe that neglecting to educate people about consequences is a serious shortcoming in risk information programs. For example, an adequate discussion of risk cannot assume that people have good knowledge of what it's like to experience a certain disease, the pains, the discomforts, the treatments and their effects, etc. This sort of information might best come from those who are the victims of such diseases. Research is needed to determine how best to deepen perspectives about the novel, unfamiliar consequences associated with the outcomes of illnesses, accidents, and their treatments.

7.2. Information relevance. What lessons do people draw about their own vulnerability to a hazard on the basis of risk information? For example:

• What do residents living near the Union Carbide pesticide plant at Institute, West Virginia infer about their personal risk as a result of the Bhopal accident?

• What does a heterosexual individual infer about personal vulnerability to AIDS from statistics based on homosexuals?

• What does a resident of the West Coast infer about his or her risk from cancer due to polluted groundwater upon receiving risk estimates for residents of the East Coast?

Obviously, the personal message one draws from risk information will depend upon the perceived relevance of that message--but the determinants of relevance are by no means understood. There are always differences between the time and place and population (or species) from which risk information is derived and the time, place, and population with which the recipient identifies. When are these differences magnified into barriers justifying denial of relevance ("those statistics don't really pertain to me") and when are the barriers made permeable and the message assimilated? Such questions are fundamental to the process of risk communication, yet we know virtually nothing about them.

7.3. Cognitive Representations of Perceived Risk

People's cognitive representations of risk dictate the sorts of information they will find necessary for participating in risk-management decisions. Thus, if characteristics of risk influence

perceptions and behaviors, we will need to provide people with information about how well a hazard is known to science, the extent of its catastrophic potential, and other important considerations. If people examine accident reports for their signal value, then methods are needed to assess this factor and communications techniques are needed to express it meaningfully. However, we still lack a full understanding of the ways in which people characterize risk. Research is needed to provide a clearer picture of the multiple ways to represent perceptions and the variations of these representations across different individuals and groups (Harding & Eiser, 1984; Kuyper & Vlek, 1984; Kraus, 1985).

The multivariate characterizations that have emerged from psychometric studies demonstrates that there are many things to be considered when thinking about risk and many (possibly incommensurable) factors to bear in mind when assessing the riskiness of different hazards. The need for some convenient general summary measure of risk seems apparent. Reliance on multiattribute utility theory to construct such an index (Fischhoff, Watson, & Hope, 1984) provides one approach, but research is needed to determine if people can provide the explicit judgments needed to create such an index. Given an index, can people absorb the information it summarizes in a way that is meaningful and will they make or accept decisions based on it? Would they feel more comfortable being shown, in matrix or vector form, the component information it summarizes?

7.4. Risk and the media

We need a theoretical framework to understand and improve the media's role in communicating risk. Some theorists, such as Gans (1980)

have proposed that one major role of journalism is to report events that threaten or violate important values--such as preserving a stable social order. In this light, things that "go awry," and thereby threaten natural, technological, social or moral disorder, become prime news topics. The relation between hazard characteristics and news coverage should be examined to discern more precisely how the media interpret their responsibility to warn society.

One possibility is that coverage of risk incidents is systematically related to threat potential or signal value. If so, such coverage (as measured by frequency, size, and prominence of reports) should be related to the same characteristics that predict other risk perceptions and attitudes. Thus, incidents involving hazards perceived as unknown, dread, and potentially catastrophic would be expected to receive much greater coverage than incidents involving hazards with other characteristics. Data reported by Kristiansen (1983) provides some support for these notions. Her study of seven British daily newspapers found that threats with high signal value such as infectious diseases, food poisoning, and rabies, were disproportionately reported relative to their frequency of occurrence.

Content analyses of media reports need to be supplemented by more controlled studies. An intriguing example of a controlled study was done by Johnson and Tversky (1983) who asked subjects to judge the perceived frequency of death from various causes after reading a single newspaper-style story about a tragic incident involving the death of a young man. The cause of death was either leukemia, homicide or fire, depending on the story. They expected to find that a story would

increase perceived frequency most for the specific hazard involved in the story, with somewhat smaller increases for similar hazards.

Instead, the results indicated large increases in perceived frequencies for all hazards, with size of increase being unrelated to similarity.

They hypothesized that the stories aroused negative affect which had a general influence on perception. This hypothesis is an important one, in need of further study, because it implies that media coverage might influence our perceptions of threat in subtle and pervasive ways.

Other topics that could be studied by means of controlled news simulations are the reporting (or deletion) of uncertainties in risk estimates and the treatment given expert disagreements. How, for example, would journalists report a story in which 20 experts argued one way and one argued another? Would it matter if the ratio were higher or lower or if the dissenter had more or less prestigious credentials? Would experienced journalists or their editors treat the story differently than inexperienced reporters? Would the type of medium (TV, radio, print) make a difference? In sum, studies like these could point out biases or inadequacies in reporting about which journalists need to be informed.

8. CONCLUSIONS

Some observers, cognizant of the communication difficulties described above, have concluded that they are insurmountable. This seems an unreasonably pessimistic view. Upon closer examination, it appears that people understand some things quite well, although their path to knowledge may be quite different from that of the technical experts. In situations where misunderstanding is rampant, people's

errors can often be traced to biased experiences, which education may be able to counter. In some cases, people's strong fears and resistance to experts' reassurances can be traced to their sensitivity to the potential for catastrophic accidents, to their perception of expert disagreement about the probability and magnitude of such accidents, and to their knowledge of serious mistakes made by experts in the past and to their sensitivity to many qualitative concerns not included in technical risk analyses. Even here, given an atmosphere of trust in which both experts and lay persons recognize that each group has something to contribute to the discussion, exchange of information and deepening of perspectives may well be possible.

9. ACKNOWLEDGEMENT

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Table 1

ANNUAL FATALITY RATES PER 100,000 PERSONS AT RISK

<u>RISK</u>	<u>RATE</u>
MOTORCYCLING	2000
ALL AGES	1000
AERIAL ACROBATICS (PLANES)	500
SMOKING (ALL CAUSES)	300
SPORT PARACHUTING	200
SMOKING (CANCER)	120
FIRE FIGHTING	80
HANG GLIDING	80
COAL MINING	63
FARMING	36
MOTOR VEHICLES	24
POLICE WORK (NON-CLERICAL)	22
BOATING	5
RODEO PERFORMER	3
HUNTING	3
FIRES	2.8
1 DIET DRINK/DAY (SACCHARIN)	1.0
4 TBS. PEANUT BUTTER/DAY (AFLATOXIN)	0.8
FLOODS	0.06
LIGHTNING	0.05
METEORITE	0.000006

Source: Adapted from Crouch & Wilson (1982).

Table 2

ESTIMATED LOSS OF LIFE EXPECTANCY DUE TO VARIOUS CAUSES

CAUSE	DAYS
CIGARETTE SMOKING (MALE)	2,250
HEART DISEASE	2,100
BEING 30% OVERWEIGHT	1,300
BEING A COAL MINER	1,100
CANCER	980
STROKE	520
ARMY IN VIETNAM	400
DANGEROUS JOBS, ACCIDENTS	300
MOTOR VEHICLE ACCIDENTS	207
PNEUMONIA, INFLUENZA	141
ACCIDENTS IN HOME	95
SUICIDE	95
DIABETES	95
BEING MURDERED (HOMICIDE)	90
DROWNING	41
JOB WITH RADIATION EXPOSURE	40
FALLS	39
NATURAL RADIATION (BEIR)	8
MEDICAL X-RAYS	6
COFFEE	6
ALL CATASTROPHES COMBINED	3.5
REACTOR ACCIDENTS (UCS)	2 ^A
RADIATION FROM NUCLEAR INDUSTRY	0.02 ^A

^ATHESE ITEMS ASSUME THAT ALL U.S. POWER IS NUCLEAR. UCS IS UNION OF CONCERNED SCIENTISTS, THE MOST PROMINENT GROUP OF CRITICS OF NUCLEAR ENERGY.

SOURCE: B. COHEN AND LEE, 1979.

Table 3

RISKS ESTIMATED TO INCREASE CHANCE OF DEATH IN ANY YEAR BY 0.000001 (1 PART IN 1 MILLION)

<u>ACTIVITY</u>	<u>CAUSE OF DEATH</u>
SMOKING 1.4 CIGARETTES	CANCER, HEART DISEASE
SPENDING 1 HOUR IN A COAL MINE	BLACK LUNG DISEASE
LIVING 2 DAYS IN NEW YORK OR BOSTON	AIR POLLUTION
TRAVELING 10 MILES BY BICYCLE	ACCIDENT
FLYING 1,000 MILES BY JET	ACCIDENT
LIVING 2 MONTHS IN DENVER ON VACATION FROM NEW YORK	CANCER CAUSED BY COSMIC RADIATION
ONE CHEST X-RAY TAKEN IN A GOOD HOSPITAL	CANCER CAUSED BY RADIATION
EATING 40 TABLESPOONS OF PEANUT BUTTER	LIVER CANCER CAUSED BY AFLATOXIN B
DRINKING 30 12-OZ. CANS OF DIET SODA	CANCER CAUSED BY SACCHARIN
DRINKING 1,000 24-OZ. SOFT DRINKS FROM RECENTLY BANNED PLASTIC BOTTLES	CANCER FROM ACRYLONITRILE MONOMER
LIVING 150 YEARS WITHIN 20 MILES OF A NUCLEAR POWER PLANT	CANCER CAUSED BY RADIATION
RISK OF ACCIDENT BY LIVING WITHIN 5 MILES OF A NUCLEAR REACTOR FOR 50 YEARS	CANCER CAUSED BY RADIATION

SOURCE: R WILSON, 1979.

Table 4. Characteristics Examined in Psychometric Studies of Perceived Risk.

- Voluntary - Involuntary
- Chronic - Catastrophic
- Common - Dread
- Injurious - Fatal
- Known to those exposed - Not known to those exposed
- Known to science - Not known to science
- Controllable - Not controllable
- Old - New

Table 5

Questions to Ask of Risk Analyses

Reporters should consider the following questions whenever a risk analysis is produced for use in policy decisions:

- (1) Does the risk analysis state the probability of the potential harm as well as the amount of harm expected?
- (2) Does the risk analysis disclose forthrightly the points at which it is based on assumptions and guesswork?
- (3) Are various risk factors allowed to assume a variety of values depending on uncertainties in the data and/or various interpretations of the data?
- (4) Does the risk analysis multiply its probabilities by the number of people exposed to produce the number of people predicted to suffer damage?
- (5) Does the risk analysis disclose the confidence limits for its projections and the method of arriving at those confidence limits?
- (6) Are considerations of individual sensitivities, exposure to multiple hazards and cumulative effects included in the risk analysis?
- (7) Are all data and processes of the risk analysis open to public scrutiny?
- (8) Are questions of (a) involuntary exposure, (b) who bears the risks and who reaps the benefits and (c) alternatives to the hazardous activity considered in the risk analysis?
- (9) Are the processes of risk analysis and risk policy separate?

If the answer to any of these questions is "no," then the use of that risk analysis should be questioned.

Source: Adapted from Fischhoff, (1985a).

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