Informing People About Risk

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Running Head: Informing People

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Introduction

One dramatic change in people's outlook on life in recent years is their growing awareness of the risks they encounter in daily experience. Radiation hazards, medicinal side-effects, occupational disease, food contaminants, toxic chemicals, and mechanical malfunctions increasingly seem to fill our newspapers and conversations. The consequence of this awareness has been growing pressure on the designers and regulators of hazardous enterprises to inform people about the risks they face (see Figure 1). For example:

• The Food and Drug Administration is mandating patient information inserts for an increased number of prescription drugs.

• The Department of Housing and Urban Development now requires the sellers of homes built before 1950 to inform buyers about the presence of lead-based paints.

• The proposed federal products liability law places increased weight on adequately informing consumers and workers about risks they are likely to encounter.

• The White House has directed the Secretary of Health, Education and Welfare to develop a public information program on the health effects of radiation exposure.

Insert Figure 1 about here

We strongly support the notion that the public needs to be informed about risk, in order to make better personal decisions and to participate more effectively in the political processes whereby societal standards are developed and enforced. However, the proper format of an effective information program is by no means evident at this time. Designers of information statements must be fully aware of the difficulties in conveying risk information in a way that helps people make decisions. To be effective, any information program must be buttressed by extensive empirical research focused on understanding public attitudes and developing effective ways of presenting information about risks. Research is needed to determine:

(1) What people know,

(2) What they want to know,

(3) How to express information about risks and consequences, bearing in mind the difficulties people have in comprehending such information (e.g., what are the most relevant and most easily comprehended units in which to express risk?), and

(4) The ethical, legal and political issues raised by such information programs (e.g., the dilemma posed by the possibility that patients might refuse needed medical treatments because of fears aroused by the information program).

Confronting Human Limitations

Disseminating information about risk is an empty exercise unless it is presented in an understandable fashion. Doing an adequate job means finding cogent ways of presenting complex, technical information which is sometimes clouded with uncertainty. Not only is the allotted time often very limited, but the message about risk must confront the listeners' preconceptions (and perhaps misconceptions) about the hazard in question and its consequences. What follows is a brief overview of some of the problems that any information program must confront.

It Is Hard To Think Clearly About Risk

Decisions about risk require sophisticated reasoning on the part of both experts and the public. Needed are an appreciation of the probabilistic nature of the world and the ability to think intelligently about rare (but consequential) events. Unfortunately, although the human intellect is deservedly held in high esteem in many contexts, numerous studies have shown that intelligent people have difficulty coping with risk and uncertainty.

One source of difficulty can be traced to the use of judgmental heuristics, mental strategies whereby people try to reduce difficult tasks to simpler judgments (Tversky & Kahneman, 1974). These heuristics are valid in some circumstances, but in others, they lead to biases that are large, persistent, and serious in their implications for decision making.

People's Perceptions of Risks are Often Inaccurate

Extensive discussions of heuristics and biases in probabilistic thinking are available in the literature (Slovic, Kunreuther & White, 1974; Slovic, Fischhoff & Lichtenstein, 1977). However, one heuristic bears mention here because of its special relevance to perceptions of risk. This is the "availability heuristic" whereby an event is judged likely or frequent if it is easy to imagine or recall relevant instances of that event. In reality, instances of frequent events are typically easier to recall than instances of less frequent events, and likely occurrences are easier to imagine than unlikely ones. Thus availability is often an appropriate cue for judging frequency and probability. However, since availability is also affected by numerous factors unrelated to likelihood, reliance on it may lead to overestimation of probabilities for recent, vivid, emotionally salient, or otherwise memorable or imaginable events. In the extreme, any factor that makes a hazard unusually memorable or imaginable, such as a recent disaster or a vivid film (e.g., "Jaws" or "The China Syndrome"), could seriously distort that hazard's perceived risk.

We have recently collected data on the perceived frequency of various causes of death that show the biasing effects of availability (Lichtenstein, Slovic, Fischhoff, Layman & Combs, 1978). We found that the frequencies of dramatic or sensational causes of death, such as accidents, homicide, cancer, botulism, and tornadoes, were greatly overestimated. Frequencies of undramatic causes, such as asthma, emphysema and diabetes, which take one life at a time and are common in non-fatal form, were greatly underestimated. News media coverage of fatal events is biased in much the same direction, thus contributing to the difficulties of keeping proper mental accounts of everday risks (Combs & Slovic, 1979).

Another important type of misperception is the tendency to consider ourselves personally immune to many hazards that we admit pose a serious threat to others. In a report titled, "Are We All Among the Better Drivers?", Svenson (1979) showed that most people rate themselves as among the most skillful and safe drivers in the population. This effect does not seem to be limited just to driving. Rethans (1979) found that people rated their personal risk from each of 29 consumer products (e.g., knives, hammers) as lower than the risk to other individuals. Ninety-seven percent of Rethans' respondents judged themselves average or above average in their ability to avoid both bicycle and power mower accidents. Weinstein (1979a) found that people were unrealistically optimistic when evaluating the chances that a wide variety of good and bad life events (e.g., living past 80, having a heart attack) would happen to them.

Although the determinants of such personal optimism are not well understood, we believe that several contributing factors can be identified. First, the hazardous activities for which personal risks are underestimated tend to be seen as under the individual's control. Second, they tend to be familiar hazards whose risks are so low that the individual's personal experience is overwhelmingly benign. Automobile driving is a prime example of such a hazard. Despite driving too fast, tailgating, etc., poor drivers make trip after trip without mishap. This personal experience demonstrates to these drivers their exceptional skill and safety. Moreover, their indirect experience via the media shows them that accidents do happen--to others. Given such misleading experiences, people may feel quite justified in refusing to take protective action such as wearing seat belts (Slovic, Fischhoff & Lichtenstein, 1978).

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 probability, 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 (Rosenberg, 1978), but controlled research is needed to test it more adequately. To the extent that imaginability can blur the distinction between what is (remotely) possible and what is probable, information materials will have to be designed with great care.

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 (Lichtenstein & Slovic, 1973; Slovic, in press). 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 so small 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. Thus, just before hearing a blue-ribbon panel of scientists report being 95% certain that cyclamates do not cause cancer, former Food and Drug Administration Commissioner Alexander Schmidt said, "I'm looking for a clean bill of health, not a wishy-washy, iffy answer on cyclamates." Likewise, Senator Muskie has called for "one-armed" scientists who do not respond "on the one hand, the evidence is so, but on the other hand . . ." when asked about the health effects of pollutants.

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 anxious and conflicted (see, e.g., Alfidi, 1971; Fischhoff, in press; Weinstein, in press).

Strong Beliefs Are Hard to Modify

The difficulties of facing life as a gamble contribute to the polarization of opinion about hazards such as nuclear power or genetic recombinations; some view these technologies as extraordinarily safe, while others view them as catastrophes in the making. 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. Once formed, initial impressions tend toostructure the way that substantive evidence is interpreted. New evidence appears reliable and informative if it is consistent with one's initial belief; contraty evidence is dismissed as unreliable, erroneous, or unrepresentative. Thus, depending on whether one is predisposed to favor nuclear power or oppose it, efforts to reduce nuclear hazards may be interpreted to mean either that the technologists are responsive to the public's concerns or that the risks are indeed great. Similarly, whereas opponents of nuclear power viewed the accident at Three Mile Island as proof that nuclear reactors are unsafe, proponents claimed that it demonstrated the effectiveness of the multiple safety and containment systems.

The difficulty of modifying opinions by educational programs is illustrated by the Swedish government's massive campaign to inform people about nuclear power and other energy sources. Ten or more hours of instruction had little influence on the attitudes of the 80,000 participants. The most significant effect was an increase in uncertainty about nuclear power, caused by an inability to resolve the conflicting opinions of technical experts.

Are People Educable About Risks?

We have attempted to demonstrate some of the difficulties people have in comprehending and estimating risks. Some observers, cognizant of these difficulties, have concluded that they are insurmountable. We disagree. Although the broad outlines of psychological research in decision making and risk taking seem to support a pessimistic view, the details of that research give some cause for optimism. 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 awareness of expert disagreement about the probability and magnitude of such accidents, and to their knowledge of serious mistakes made by experts in the past. Even here, given an atmosphere of trust, in which both experts and lay persons recognize that each group may have something to contribute to the discussion, exchange of information and deepening of perspectives may well be possible.

Placing Risks in Perspective

There seems to be general agreement among the technical community that appropriate presentations of factual material can go a long way towards educating the public about the nature and magnitude of societal risks. In this section we shall discuss a few of the problems and issues that arise in the design of programs for placing risks in perspective.

Presentation Format Is Vitally Important

Subtle changes in the way that risks are expressed can have major impact on our perceptions and behaviors. There is a large psychological literature documenting this assertion. Here, we shall present only a brief introduction to the topic. Our first example is based on two problems that Tversky and Kahneman (in press) gave to a group of physicians. Each problem had two options and the physicians were asked to indicate which option they would choose.

Problem 1. Imagine that the U.S. is preparing for the outbreak of an unusual Asian disease, which is expected to kill 600 people. Two alternative programs to combat the disease have been proposed. Assume that the consequences of the programs are as follows:

If Program A is adopted, 200 people will be saved.

If Program B is adopted, there is 1/3 probability that 600 people will be saved, and 2/3 probability that no people will be saved.

Which of the two programs would you favor?

Problem 2. (Same cover story as Problem 1)

If Program C is adopted, 400 people will die.

If Program D is adopted, there is 1/3 probability that nobody will die, and 2/3 probability that 600 people will die.

Which of the two programs would you favor?

Seventy-five percent of the physicians chose Program A over Program B and 67% chose Program D over Program C. On closer examination, one can see that A and C are identical options, as are B and D. The preference patterns of many physicians were inconsistent, reversed by the simple change from lives saved to lives lost.

A second demonstration of the importance of the presentation format comes from a study of attitudes towards the use of automobile seat belts (Slovic, Fischhoff & Lichtenstein, 1978). Drawing upon previous research showing that probability of loss was more important than the magnitude of loss in triggering protective action, Slovic et al. argued that the reluctance of people to wear seat belts voluntarily was understandable in light of the extremely small probability of a fatal accident on a single automobile trip. Given the fact that only about 1 in every 3.5 million person trips ends in a fatal accident and about 1 in every 100,000 person trips results in a disabling injury, failure to buckle one's seat belt cannot be considered an unreasonable action. Slovic et al. further argued that voluntary use of seat belts depends on motorists believing that their personal likelihood of being in an accident is high enough to make wearing a belt seem sensible. They suggested that motorists be informed that over a 50-year lifetime of driving (about 40,000 trips), the probability of a fatal accident rises to .01 and the probability of experiencing at least one disabling injury is .33. Their research showed that people induced to consider the lifetime perspective did, in fact, respond more favorably (compared to people induced to consider a trip-by-trip perspective) towards use of seat belts and towards the enactment of laws that required the wearing of seat belts or the installation of air bags. Whether the favorable attitudes towards seat belts engendered by a lengthened time perspective would be maintained and translated into behavior, remains to be seen.

Numerous other format effects have been documented in the psychological literature. For example, people have been found to evaluate gambles much differently when they consider them in pairs than when they judge them singly (Grether & Plott, 1979; Lichtenstein & Slovic, 1971; 1973). Schoemaker and Kunreuther (1980) have shown that decisions about whether or not to buy insurance are frequently reversed when the problem is portrayed as a choice between facing a gamble or accepting a certain loss of a small amount of money (paying the premium). Additional demonstrations of format and context effects can be found in Fischhoff, Slovic and Lichtenstein (in press), Kahneman and Tversky (1979), and Tversky and Kahneman (in press).

The fact that subtle differences in how risks are presented can have marked effects on how they are perceived suggests that people who inform others 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.

Cross-Hazard Comparisons May Be Misleading

One of the most valued approaches for deepening people's perspectives is to present quantified risk estimates for a variety of hazards. Presumably, the sophistication gleaned from examining such data will be useful for personal and societal decision making. Wilson (1979) observed that we should "try to measure our risks quantitatively. . . . Then we could compare risks and decide which to accept or reject" (p. 43). Likewise, Sowby (1965) argued that to decide whether or not we are regulating radiation hazards properly, we need to pay more attention to "some of the other risks of life," and Lord Rothschild (1979) recently added, "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."

Typically, such exhortations are followed by elaborate tables and even "catalogs of risks" in which diverse indices of death or disability are displayed for a broad spectrum of life's hazards. Thus Sowby (1965) provided extensive data on risks per hour of exposure, showing, for example, that a hour riding a motorcycle is as risky as an hour of being 75 years old. Wilson (1979) developed Table 1, which displays a set of activities, each of which is estimated to increase one's chances of death (during any year) by 1 in one million (which in the case of accidental death would decrease one's life expectancy by an average of about 15 minutes). Wilson claimed that ". . . these comparisons help me evaluate risks 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" (p. 45). In similar fashion, Cohen and Lee (1979) ordered many hazards in terms of their expected reduction in life expectancy (Table 2) on the assumption that "to some approximation, the ordering (in this table) should be society's order of priorities. However, we see several very major problems that have received very little attention . . . whereas some of the items near the bottom of the list, especially those involving radiation, receive a great deal of attention" (Cohen & Lee, 1979, p. 720).

Insert Tables 1 and 2 about here

Properly speaking, comparing hazards is not a decision-making procedure, but merely an aid to intuition. The logic of the calculations does not require any particular conclusion to be drawn, say, from the contrast between the risks of motorcycling and advanced age (Fischhoff, Slovic, Lichtenstein, Derby & Keeney, 1980). Moreover, cross-hazards comparisons have a number of inherent limitations. For example, although some people feel enlightened upon learning that a single takeoff or landing in a commercial airliner takes an average of 15 minutes off one's life expectancy, others find themselves completely bewildered by such information. On landing, one will either die prematurely (almost certainly by more than 15 minutes) or one will not. To many people, averages seem inadequate to capture the essence of such risks.

Summary statistics, like those in Tables 1 and 2 often mask some important characteristics of risk. Where there is lack of knowledge or disagreement about the facts, some indication of uncertainty is needed. Since people seem to view a catastrophic accident as much more aversive than numerous small accidents killing the same number of people (Ferreira & Slesin, 1976; Slovic, Fischhoff & Lichtenstein, in press), more than averages or expected values is needed to provide them with the information they want. Other characteristics important in determining people's reactions to hazards, but neglected in Tables 1 and 2, are the voluntariness, controllability, and familiarity of the risk, the immediacy of the consequences, the degree to which its benefits are distributed equitably to those who bear its risk, the possibility of damage to future generations, and the ease of reducing the risk.

It is all too easy for arithmetically facile analysts to get carried away by the ease of computing risk statistics. Statements such as "the risk from nuclear power is equal to the risk of riding in automobiles and extra three miles," because they ignore differences between automobiles and nuclear power with regard to level of uncertainty, catastrophic potential, equity, and other important characteristics, produce outrage rather than enlightenment and lead some to characterize the arithmetic of cross-hazards comparisons as "only the kindergarten of risk" (Nature, 1978). Although some faults, such as the omission of uncertainty bands, are easy to correct, determining how to properly weight the other important considerations will require a serious research effort.

What Can Research Tell Us?

Research is needed to tell us what the public knows, what it wants to know, and how to design and evaluate informational programs. For example, some have speculated that people shy away from information of a threatening nature. However, psychologist Neil Weinstein (in press) found the opposite reaction when people were given the opportunity to choose between a reassuring and a threatening message about environmentally induced cancer. His conclusions have obvious relevance for the design of public information programs. Specifically, he found that:

- People were more interested in learning what the hazard might be than in receiving information minimizing its danger.
- Failure to seek information reflected a lack of interest in the topic rather than an attempt to avoid the topic because it was too threatening.
- Lack of information or even self-perceived lack of information does not necessarily lead people to seek out information.
- When conflicting messages are available regarding the existence of a hazard, people tend to select the message that agrees with their own point of view.

Information about Risks from Prescription Drugs

An unpublished study by Baruch Fischhoff provides a detailed example of the way in which research can be carried out and the kinds of insights such research might provide. Fischhoff was concerned about people's reactions to various patient package inserts designed to inform them of the risks from oral contraceptives. He had one group of people read an insert designed for doctors. A second group read a statement designed for patients. Both inserts were written by a major drug company. The only change Fischhoff made in these inserts was to remove any material indicating that the drug, labeled Drug X, was an oral contraceptive. After reading the inserts, participants in the study were asked to fill out a questionnaire designed to assess their understanding of the material and their opinions about the drug and its side effects.

Analysis of the questionnaires showed that virtually all of the readers felt that the information provided them, which was quite detailed, was important. They believed that it would be inappropriate to withhold any of it from a potential user of the drug. Nevertheless, after reading the insert, most felt that they did not understand the risks very well, nor did they believe that scientists understood them well. When compared with other drugs, Drug X was judged riskier than vitamin C, aspirin, marijuana, coffee, and alcohol. It was judged about as risky as birth control pills, cortisone, and amphetamines. Its riskiness, relative to these other drugs, was greater with the doctor's form. On the average, readers of both forms said they would <u>not</u> take Drug X to relieve allergies, migraine headaches, or arthritis pain, nor even to prevent conception, control diabetes, or prevent cancer.

Congruent with the discussion earlier in this paper, Fischhoff found that both presentation format and mode of questioning had strong effects on perceived risk from Drug X. Specifically, readers of the doctors' form thought that frequency of blood clots (the major risk described) was 2.5 times as large for users as for non-users; readers of the patients' form thought that it was 5.1 times as large. On the other hand, readers of the patients' form estimated a much lower overall rate of fatal side effects (1 in 40,000 users vs. 1 in 2,000). The reason for this inconsistency seems to be that the patients' version gave a number of representative death and morbidity rates, revealing that the absolute value of a relatively high risk was an order of magnitude smaller than that imagined by readers of the doctors' form. Had only one risk question been asked, one would have had a rather different picture of readers' knowledge and the effect of the textual differences in the two inserts.

A recently completed dissertation by Keown (1980) sheds further light on the effects of presentation format upon peoples's evaluation of patientspackage inserts. Keown found that most of his respondents, college students and members of the general public, wanted to be informed of serious side effects (e.g., blood clot, liver damage) even if they occurred very infrequently (as low as once in every 10 million drug users). However, if the side effect was of minor significance (e.g., sore throat, slow pulse rate), they did not want it included in a package insert unless it occurred quite frequently (one or more times in 1,000 users).

In a second study, Keown has found that brief descriptions about side effects (e.g., adding the phrase "a tendency to develop black and blue marks" as a description of the effect "abnormal bruising") changed people's perceptions of their seriousness. In most cases, the descriptions led the effect to be considered less serious. Keown also found that long lists of very rare side effects caused disproportionate concern among lay people. That is, people seemed to be weighing the number of side effects too highly, relative to their frequencies, in evaluating drug risk. Although further research is needed here, this result does lend credence to physicians' concerns that listing of rare side effects might frighten patients and cause them to do without needed medication.

Fischhoff (in press) described a research program needed in the design of statements to inform workers about occupational hazards. In the context of informing workers about radiation risks, Fischhoff noted that among the considerations such statements could address are: (a) Who sets the standards? (b) What is the likelihood of their being exceeded by accident? (c) What other hazards cause similar effects? (d) Does the company make a profit on the labor that exposes the workers? (e) How do risks from repeated exposures cumulate? (f) What percentage of workers willingly accept the stated risks? Fischhoff's initial studies showed that varying the treatment of these issues in information statements had a considerable effect on workers' stated attitudes toward the work and the wage it merited.

How and By Whom Should Information Be Provided?

Risk information programs have enormous potential to influence the behavior of workers, patients, and consumers. The stakes are high--product viability, jobs, electricity costs, willingness of patients to submit to necessary treatments, public safety and health, etc. Potential conflicts of interest abound. Responsibility for information programs should not be left solely to the natural triumvirate of science, industry and government, lest these programs run the risk of being viewed as mere propaganda campaigns. Since every decision about the design of an information statement is likely to influence perception and behavior, extreme care must be taken to select knowledgeable and trustworthy designers and program coordinators. We cannot propose a general solution here, as a competent and credible program staff would have to be put together in consultation with representatives of the people who are to be informed. If these people do not trust the designers and administrators, there is little point in pursuing the program.

The value of labels that warn against ingesting or mishandling toxic substances such as lye or pesticides is obvious. However, in light of the issues raised in this paper, we must question the value of labels warning about substances whose toxicity is far from certain (e.g., saccharin). If not ignored, such labels are likely to confuse people or raise their anxiety level, without providing much information relevant to decision making. Labels are certainly no substitute for a carefully planned and detailed program of information about the risks and benefits of the hazard in question. At the least, warning labels should direct the reader to more adequate sources of information.

It is important to recognize that informing people, whether by labels, package inserts, or more extensive programs, is but part of the larger problem of helping people cope with the risks and uncertainties of modern life. We believe that part of the responsibility lies with our schools. Curricula in elementary and secondary schools should include material designed to teach people that the world in which they live is probabilistic, not deterministic, and to help them learn judgment and decision strategies for dealing with that world. These strategies are as necessary for navigating in a world of uncertain information as geometry and trigonometry are to navigating among physical objects.

Summary

The development of programs to inform patients, workers, and consumers about risks is an admirable goal, which we endorse fully. However, it is important to recognize the difficulties inherent in attempting to communicate highly technical information to people. There is a need for an extensive program of empirical research on the problems of communicating information about risk. If this research fulfills its promise, not only would we know that it is possible to design valid presentations, but we would also have generic guidelines on how to do so. Since fundamental psychological processes are involved, one would not have to design each informational statement from scratch; rather, one could convene panels of technical experts, communication experts and representatives of the target population to develop the presentations needed for explaining specific hazards.

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Table 1

Risks Which Increase the Chance of

Death in any Year by .000001*

Smoking 1.4 cigarettes	Cancer, heart disease
Drinking 1/2 liter of wine	Cirrhosis of the liver
Spending 1 hour in a coal mine	Black lung disease
Spending 3 hours in a coal mine	Accident
Living 2 days in New York or Boston	Air pollution
Travelling 6 minutes by canoe	Accident
Travelling 10 miles by bicycle	Accident
Travelling 300 miles by car	Accident
Flying 1000 miles by jet	Accident
Flying 6000 miles by jet	Cancer caused by cosmic radiation
Living 2 months in Denver on vacation from N.Y.	Cancer caused by cosmic radiation
Living 2 months in average stone or brick building	Cancer caused by natural radioactivity
One chest x-ray taken in a good hospital	Cancer caused by radiation
Living 2 months with a cigarette smoker	Cancer, heart disease
Eating 40 tablespoons of peanut butter	Liver cancer caused by aflatoxin B
Drinking Miami drinking water for 1 year	Cancer caused by chloroform
Drinking 30 12 oz. cans of diet soda	Cancer caused by saccharin
Living 5 years at site boundary of a typical nuclear power plant in the open	Cancer caused by radiation
Drinking 1000 24 oz. soft drinks from recently banned plastic bottles	Cancer from acrylonitrile monomer
Living 20 years near PVC plant	Cancer caused by vinyl chloride (1976 standard)
Living 150 years within 20 miles of a nuclear power plant	Cancer caused by radiation
Eating 100 charcoal broiled steaks	Cancer from benzopyrene
Risk of accident by living within 5 miles of a nuclear reactor for 50 years	Cancer caused by radiation

*(1 part in 1 million)

from Wilson, 1979.

Table 2

Loss of Life Expectancy (ΔE) Due to Various Causes

Cause	Days
Being unmarried--male	3500
Cigarette smoking--male	2250
Heart disease	2100
Being unmarried--female	1600
Being 30% overweight	1300
Being a coal miner	1100
Cancer	980
20% Overweight	900
<8th Grade education	850
Cigarette smoking--female	800
Low socioeconomic status	700
Stroke	520
Living in unfavorable state	500
Army in Vietnam	400
Cigar smoking	330
Dangerous job--accidents	300
Pipe smoking	220
Increasing food intake 100 cal/day	210
Motor vehicle accidents	207
Pneumonia--influenza	141
Alcohol (U.S. average)	130
Accidents in home	95
Suicide	95
Diabetes	95
Being murdered (homicide)	90
Legal drug misuse	90
Average job--accidents	74
Drowning	41
Job with radiation exposure	40
Falls	39
Accidents to pedestrians	37
Safest jobs--accidents	30
Fire--burns	27
Generation of energy	24
Illicit drugs (U.S. average)	18
Poison (solid, liquid)	17
Suffocation	13
Firearms accidents	11
Natural radiation (BEIR)	8
Medical X rays	6
Poisonous gases	7
Coffee	6
Oral contraceptives	5
Accidents to pedalcycles	5
All catastrophes combined	3.5
Diet drinks	2
Reactor accidents (UCS)	2*
Reactor accidents--Rasmussen	0.02*
Radiation from nuclear industry	0.02*
PAP test	-4
Smoke alarm in home	-10
Air bags in car	-50
Mobile coronary care units	-125
Safety improvements 1966-76	-110

*These items assume that all U.S. power is nuclear. UCS is Union of Concerned Scientists, the most prominent group of nuclear critics.

From Cohen and Lee (1979).

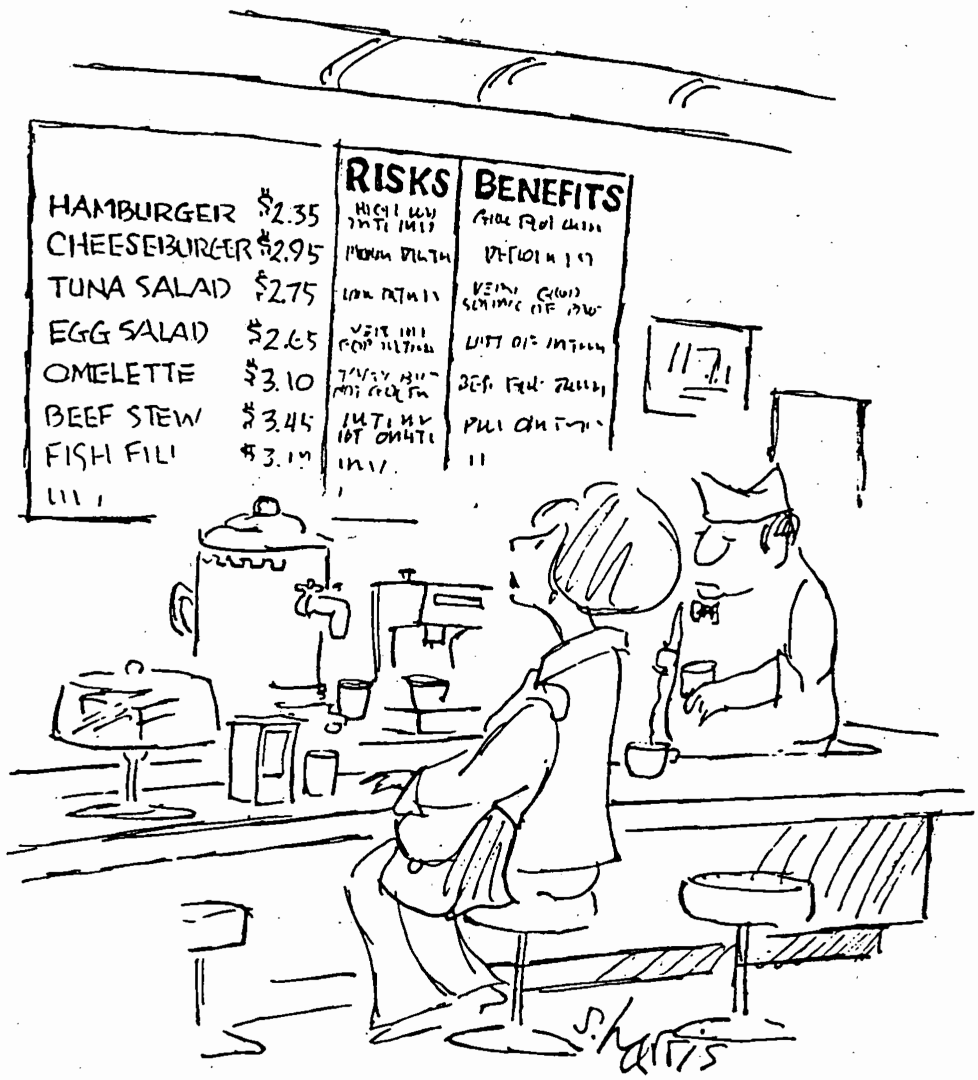

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Figure 1