Trust, Emotion, Sex, Politics, and Science: Surveying the Risk-Assessment Battlefield

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Abstract

Risk management has become increasingly politicized and contentious. Polarized views, controversy, and conflict have become pervasive. Research has begun to provide a new perspective on this problem by demonstrating the complexity of the concept "risk" and the inadequacies of the traditional view of risk assessment as a purely scientific enterprise.

This paper argues that danger is real, but risk is socially constructed. Risk assessment is inherently subjective and represents a blending of science and judgment with important psychological, social, cultural, and political factors. In addition, our social and democratic institutions, remarkable as they are in many respects, breed distrust in the risk arena.

Whoever controls the definition of risk controls the rational solution to the problem at hand. If risk is defined one way, then one option will rise to the top as the most cost-effective or the safest or the best. If it is defined another way, perhaps incorporating qualitative characteristics and other contextual factors, one will likely get a different ordering of action solutions. Defining risk is thus an exercise in power.

Scientific literacy and public education are important, but they are not central to risk controversies. The public is not irrational. Their judgments about risk are influenced by emotion and affect in a way that is both simple and sophisticated. The same holds true for scientists. Public views are also influenced by worldviews, ideologies, and values; so are scientists' views, particularly when they are working at the limits of their expertise.

The limitations of risk science, the importance and difficulty of maintaining trust, and the complex, sociopolitical nature of risk point to the need for a new approach—one that focuses upon introducing more public participation into both risk assessment and risk decision making in order to make the decision process more democratic, improve the relevance and quality of technical analysis, and increase the legitimacy and public acceptance of the resulting decisions.

Key words: Risk, risk perception, risk assessment, risk communication

1.0 INTRODUCTION

Ironically, as our society and other industrialized nations have expended great effort to make life safer and healthier, many in the public have become more, rather than less, concerned about risk. These individuals see themselves as exposed to more serious risks than were faced by people in the past, and they believe that this situation is getting worse rather than better. Nuclear and chemical technologies (except for medicines) have been stigmatized by being perceived as entailing unnaturally great risks.[(1)] As a result, it has been difficult, if not impossible, to find host sites for disposing of high-level or low-level radioactive wastes, or for incinerators, landfills, and other chemical facilities.

Public perceptions of risk have been found to determine the priorities and legislative agendas of regulatory bodies such as the Environmental Protection Agency, much to the distress of agency technical experts who argue that other hazards deserve higher priority. The bulk of EPA's budget in recent years has gone to hazardous waste primarily because the public believes that the cleanup of Superfund sites is one of the most serious environmental priorities for the country. Hazards such as indoor air pollution are considered more serious health risks by experts but are not perceived that way by the public.[(2)]

Great disparities in monetary expenditures designed to prolong life, as shown by Tengs et al.,[(3)] may also be traced to public perceptions of risk. Such discrepancies are seen as irrational by many harsh critics of public perceptions. These critics draw a sharp dichotomy between the experts and the public. Experts are seen as purveying risk assessments, characterized as objective, analytic, wise, and rational—based on the <u>real risks</u>. In contrast, the public is seen to rely on <u>perceptions of risk</u> that are subjective, often hypothetical, emotional, foolish, and irrational (see, e.g., Ref. Nos. 4–5). Weiner[(6)] defends this dichotomy, arguing that "This separation of reality and

perception is pervasive in a technically sophisticated society, and serves to achieve a necessary emotional distance . . . " (p. 495).

In sum, polarized views, controversy, and overt conflict have become pervasive within risk assessment and risk management. A desperate search for salvation through risk-communication efforts began in the mid-1980s—yet, despite some localized successes, this effort has not stemmed the major conflicts or reduced much of the dissatisfaction with risk management. This dissatisfaction can be traced, in part, to a failure to appreciate the complex and socially determined nature of the concept "risk." In the remainder of this paper, I shall describe several streams of research that demonstrate this complexity and point toward the need for new definitions of risk and new approaches to risk management.

2.0 THE SUBJECTIVE & VALUE-LADEN NATURE OF RISK ASSESSMENT

Attempts to manage risk must confront the question: "What is risk?" The dominant conception views risk as "the chance of injury, damage, or loss."[7] The probabilities and consequences of adverse events are assumed to be produced by physical and natural processes in ways that can be objectively quantified by risk assessment. Much social science analysis rejects this notion, arguing instead that risk is inherently subjective.[8–13] In this view, risk does not exist "out there," independent of our minds and cultures, waiting to be measured. Instead, human beings have invented the concept risk to help them understand and cope with the dangers and uncertainties of life. Although these dangers are real, there is no such thing as "real risk" or "objective risk." The nuclear engineer's probabilistic risk estimate for a nuclear accident or the toxicologist's quantitative estimate of a chemical's carcinogenic risk are both based on theoretical models, whose structure is subjective and assumption-laden, and whose inputs are dependent on judgment. As we shall see, nonscientists have their own models, assumptions, and subjective

assessment techniques (intuitive risk assessments), which are sometimes very different from the scientists' models.

One way in which subjectivity permeates risk assessments is in the dependence of such assessments on judgments at every stage of the process, from the initial structuring of a risk problem to deciding which endpoints or consequences to include in the analysis, identifying and estimating exposures, choosing dose-response relationships, and so on. For example, even the apparently simple task of choosing a risk measure for a well-defined endpoint such as human fatalities is surprisingly complex and judgmental. Table I shows a few of the many different ways that fatality risks can be measured. How should we decide which measure to use when planning a risk assessment, recognizing that the choice is likely to make a big difference in how the risk is perceived and evaluated?

Insert Table I about here

An example taken from Wilson and Crouch[14] demonstrates how the choice of one measure or another can make a technology look either more or less risky. For example, between 1950 and 1970, coal mines became much less risky in terms of deaths from accidents per ton of coal, but they became marginally riskier in terms of deaths from accidents per employee. Which measure one thinks more appropriate for decision making depends on one's point of view. From a national point of view, given that a certain amount of coal has to be obtained to provide fuel, deaths per million tons of coal is the more appropriate measure of risk, whereas from a labor leader's point of view, deaths per thousand persons employed may be more relevant.

Each way of summarizing deaths embodies its own set of values.[15] For example, "reduction in life expectancy" treats deaths of young people as more important than deaths of older people, who have less life expectancy to lose. Simply counting fatalities treats deaths of the old and young as equivalent; it also treats as equivalent deaths that come immediately after

mishaps and deaths that follow painful and debilitating disease. Using "number of deaths" as the summary indicator of risk implies that it is as important to prevent deaths of people who engage in an activity by choice and have been benefiting from that activity as it is to protect those who are exposed to a hazard involuntarily and get no benefit from it. One can easily imagine a range of arguments to justify different kinds of unequal weightings for different kinds of deaths, but to arrive at any selection requires a value judgment concerning which deaths one considers most undesirable. To treat the deaths as equal also involves a value judgment.

2.1 The Multidimensionality of Risk

Research has shown that the public has a broad conception of risk, qualitative and complex, that incorporates considerations such as uncertainty, dread, catastrophic potential, controllability, equity, risk to future generations, and so forth, into the risk equation.[(16)] In contrast, experts' perceptions of risk are not closely related to these dimensions or the characteristics that underlie them. Instead, studies show that experts tend to see riskiness as synonymous with probability of harm or expected mortality, consistent with the ways that risks tend to be characterized in risk assessments (see, for example, Ref. No. 17). As a result of these different perspectives, many conflicts over "risk" may result from experts and laypeople having different definitions of the concept. In this light, it is not surprising that expert recitations of "risk statistics" often do little to change people's attitudes and perceptions.

There are legitimate, value-laden issues underlying the multiple dimensions of public risk perceptions, and these values need to be considered in risk-policy decisions. For example, is risk from cancer (a dreaded disease) worse than risk from auto accidents (not dreaded)? Is a risk imposed on a child more serious than a known risk accepted voluntarily by an adult? Are the deaths of 50 passengers in separate automobile accidents equivalent to the deaths of 50 passengers in one airplane crash? Is the risk from a polluted Superfund site worse if the site is

located in a neighborhood that has a number of other hazardous facilities nearby? The difficult questions multiply when outcomes other than human health and safety are considered.

2.2 The Risk Game

There are clearly multiple conceptions of risk.[18] Thompson and Dean[19] note that the traditional view of risk characterized by event probabilities and consequences treats the many subjective and contextual factors described above as secondary or accidental dimensions of risk, just as coloration might be thought of as a secondary or accidental dimension of an eye. Accidental dimensions might be extremely influential in the formation of attitudes toward risk, just as having blue or brown coloration may be influential in forming attitudes toward eyes. Furthermore, it may be that all risks possess some accidental dimensions, just as all organs of sight are in some way colored. Nevertheless, accidental dimensions do not serve as criteria for determining whether someone is or is not at risk, just as coloration is irrelevant to whether something is or is not an eye.

I believe that the multidimensional, subjective, value-laden, frame-sensitive nature of risky decisions, as described above, supports a very different view, which Thompson and Dean call "the contextualist conception." This conception places probabilities and consequences on the list of relevant risk attributes along with voluntariness, equity, and other important contextual parameters. On the contextualist view, the concept of risk is more like the concept of a game than the concept of the eye. Games have time limits, rules of play, opponents, criteria for winning or losing, and so on, but none of these attributes is essential to the concept of a game, nor is any of them characteristic of all games. Similarly, a contextualist view of risk assumes that risks are characterized by some combination of attributes such as voluntariness, probability, intentionality, equity, and so on, but that no one of these attributes is essential. The bottom line is that, just as

there is no universal set of rules for games, there is no universal set of characteristics for describing risk. The characterization must depend on which risk game is being played.

3.0 SEX, POLITICS, AND EMOTION IN RISK JUDGMENTS

Given the complex and subjective nature of risk, it should not surprise us that many interesting and provocative things occur when people judge risks. Recent studies have shown that factors such as gender, race, political worldviews, affiliation, emotional affect, and trust are strongly correlated with risk judgments. Equally important is that these factors influence the judgments of experts as well as judgments of laypersons.

3.1 Sex

Sex is strongly related to risk judgments and attitudes. Several dozen studies have documented the finding that men tend to judge risks as smaller and less problematic than do women. A number of hypotheses have been put forward to explain these differences in risk perception. One approach has been to focus on biological and social factors. For example, women have been characterized as more concerned about human health and safety because they give birth and are socialized to nurture and maintain life.[20] They have been characterized as physically more vulnerable to violence, such as rape, for example, and this may sensitize them to other risks.[21–22] The combination of biology and social experience has been put forward as the source of a "different voice" that is distinct to women.[23–24]

A lack of knowledge and familiarity with science and technology has also been suggested as a basis for these differences, particularly with regard to nuclear and chemical hazards. Women are discouraged from studying science and there are relatively few women scientists and engineers.[25] However, Barke, Jenkins-Smith, and Slovic[26] have found that female physical scientists judge risks from nuclear technologies to be higher than do male physical scientists. Similar results with scientists were obtained by Slovic, Malmfors, Mertz, Neil, and Purchase,[27]

who found that female members of the British Toxicological Society were far more likely than male toxicologists to judge societal risks as moderate or high. Certainly the female scientists in these studies cannot be accused of lacking knowledge and technological literacy. Something else must be going on.

Hints about the origin of these sex differences come from a study by Flynn, Slovic, and Mertz[28] in which 1,512 Americans were asked, for each of 25 hazard items, to indicate whether the hazard posed (1) little or no risk, (2) slight risk, (3) moderate risk, or (4) high risk to society. The percentage of "high-risk" responses was greater for women on every item. Perhaps the most striking result from this study is shown in Figure 1, which presents the mean risk ratings separately for white males, white females, nonwhite males, and nonwhite females. Across the 25 hazards, white males produced risk-perception ratings that were consistently much lower than the means of the other three groups.

Insert Figure 1 about here

Although perceived risk was inversely related to income and educational level, controlling for these differences statistically did not reduce much of the white-male effect on risk perception.

When the data underlying Figure 1 were examined more closely, Flynn et al. observed that not all white males perceived risks as low. The "white-male effect" appeared to be caused by about 30% of the white-male sample who judged risks to be extremely low. The remaining white males were not much different from the other subgroups with regard to perceived risk.

What differentiated these white males who were most responsible for the effect from the rest of the sample, including other white males who judged risks as relatively high? When compared to the remainder of the sample, the group of white males with the lowest risk-perception scores were better educated (42.7% college or postgraduate degree vs. 26.3% in the

other group), had higher household incomes (32.1% above $50,000 vs. 21.0%), and were politically more conservative (48.0% conservative vs. 33.2%).

Particularly noteworthy is the finding that the low risk-perception subgroup of white males also held very different attitudes than the other respondents. Specifically, they were more likely than the others to:

- Agree that future generations can take care of themselves when facing risks imposed on them from today's technologies (64.2% vs. 46.9%).
- Agree that if a risk is very small it is okay for society to impose that risk on individuals without their consent (31.7% vs. 20.8%).
- Agree that science can settle differences of opinion about the risks of nuclear power (61.8% vs. 50.4%).
- Agree that government and industry can be trusted with making the proper decisions to manage the risks from technology (48.0% vs. 31.1%).
- Agree that we can trust the experts and engineers who build, operate, and regulate nuclear power plants (62.6% vs. 39.7%).
- Agree that we have gone too far in pushing equal rights in this country (42.7% vs. 30.9%).
- Agree with the use of capital punishment (88.2% vs. 70.5%).
- Disagree that technological development is destroying nature (56.9% vs. 32.8%).
- Disagree that they have very little control over risks to their health (73.6% vs. 63.1%).
- Disagree that the world needs a more equal distribution of wealth (42.7% vs. 31.3%).
- Disagree that local residents should have the authority to close a nuclear power plant if they think it is not run properly (50.4% vs. 25.1%).

- Disagree that the public should vote to decide on issues such as nuclear power (28.5% vs. 16.7%).

In sum, the subgroup of white males who perceive risks to be quite low can be characterized by trust in institutions and authorities and by anti-egalitarian attitudes, including a disinclination toward giving decision-making power to citizens in areas of risk management.

The results of this study raise new questions. What does it mean for the explanations of gender differences when we see that the sizable differences between white males and white females do not exist for nonwhite males and nonwhite females? Why do a substantial percentage of white males see the world as so much less risky than everyone else sees it?

Obviously, the salience of biology is reduced by these data on risk perception and race. Biological factors should apply to nonwhite men and women as well as to white men and women. The present data thus move us away from biology and toward sociopolitical explanations. Perhaps white males see less risk in the world because they create, manage, control, and benefit from many of the major technologies and activities. Perhaps women and nonwhite men see the world as more dangerous because in many ways they are more vulnerable, because they benefit less from many of its technologies and institutions, and because they have less power and control over what happens in their communities and their lives. Although the survey conducted by Flynn, Slovic, and Mertz was not designed to test these alternative explanations, the race and gender differences in perceptions and attitudes point toward the role of power, status, alienation, trust, perceived government responsiveness, and other sociopolitical factors, in determining perception and acceptance of risk.

To the extent that these sociopolitical factors shape public perception of risks, we can see why traditional attempts to make people see the world as white males do, by showing them statistics and risk assessments, are often unsuccessful. The problem of risk conflict and

controversy goes beyond science. It is deeply rooted in the social and political fabric of our society.

3.2 Risk Perception and Worldviews

The influence of social, psychological, and political factors also can be seen in studies examining the impact of worldviews on risk judgments. Worldviews are general social, cultural, and political attitudes that appear to have an influence over people's judgments about complex issues.[29–31] Dake[30] has conceptualized worldviews as "orienting dispositions," because of their role in guiding people's responses. Some of the worldviews identified to date are listed below, along with representative attitude statements:

- Fatalism (e.g., "I feel I have very little control over risks to my health").
- Hierarchy (e.g., "Decisions about health risks should be left to the experts").
- Individualism (e.g., "In a fair system, people with more ability should earn more").
- Egalitarianism (e.g., "If people were treated more equally, we would have fewer problems").
- Technological Enthusiasm (e.g., "A high-technology society is important for improving our health and social well-being").

People differ from one another in these views. Fatalists tend to think that what happens in life is preordained. Hierarchists like a society organized such that commands flow down from authorities and obedience flows up the hierarchy. Egalitarians prefer a world in which power and wealth are more evenly distributed. Individualists like to do their own thing, unhindered by government or any other kind of constraints.

Dake,[31,32] Jenkins-Smith[33] and others have measured worldviews with survey techniques and found them to be strongly linked to public perceptions of risk. My colleagues and I have obtained similar results. Peters and Slovic (Ref No. 34; see also Ref. No. 35), using the same

national survey data analyzed for race and gender effects by Flynn et al.,[28] found particularly strong correlations between worldviews and attitudes toward nuclear power. Egalitarians tended to be strongly anti-nuclear; persons endorsing fatalist, hierarchist, and individualistic views tended to be pro-nuclear. Peters and Slovic also showed strong correlations between worldviews and perceptions of risk from a wide range of hazards.

Table II illustrates some of the findings with regard to attitudes toward nuclear power. It shows that people who agreed that "in a fair system people with more ability should earn more" were more likely to support a local nuclear power plant than were people who disagreed with that statement. Similarly, those who agreed with the egalitarian view of equal distribution of wealth were less likely to support a nuclear power plant than were those who disagreed with that view.

Insert Table II

3.3 Risk Perception, Emotion, and Affect

The studies described in the preceding section illustrate the role of worldviews as orienting mechanisms. Research suggests that emotion is also an orienting mechanism that directs fundamental psychological processes such as attention, memory, and information processing. Emotion and worldviews may thus be functionally similar in that both may help us navigate quickly and efficiently through a complex, uncertain, and sometimes dangerous world.

The discussion in this section is concerned with a subtle form of emotion called affect, defined as a positive (like) or negative (dislike) evaluative feeling toward an external stimulus (e.g., some hazard such as cigarette smoking). Such evaluations occur rapidly and automatically — note how quickly you sense a negative affective feeling toward the stimulus word "hate" or the word "cancer."

Support for the conception of affect as an orienting mechanism comes from a study by Alhakami and Slovic.[36] They observed that, whereas the risks and benefits to society from

various activities and technologies (e.g., nuclear power, commercial aviation) tend to be positively associated in the world, they are inversely correlated in people's minds (higher perceived benefit is associated with lower perceived risk; lower perceived benefit is associated with higher perceived risk). Alhakami and Slovic found that this inverse relationship was linked to people's reliance on general affective evaluations when making risk/benefit judgments. When the affective evaluation was favorable (as with automobiles, for example), the activity or technology being judged was seen as having high benefit and low risk; when the evaluation was unfavorable (e.g., as with pesticides), risks tended to be seen as high and benefits as low. It thus appears that the affective response is primary, and the risk and benefit judgments are derived (at least partly) from it.

Finucane, Alhakami, Slovic, and Johnson[37] investigated the inverse relationship between risk and benefit judgments under a time-pressure condition designed to limit the use of analytic thought and enhance the reliance on affect. As expected, the inverse relationship was strengthened when time pressure was introduced. A second study tested and confirmed the hypothesis that providing information designed to alter the favorability of one's overall affective evaluation of an item (say nuclear power) would systematically change the risk and benefit judgments for that item. For example, providing information calling people's attention to the benefits provided by nuclear power (as a source of energy) depressed people's perception of the risks of that technology. The same sort of reduction in perceived risk occurred for food preservatives and natural gas, when information about their benefits was provided. Information about risk was also found to alter perception of benefit. A model depicting how reliance upon affect can lead to these observed changes in perception of risk and benefit is shown in Figure 2.

Insert Figure 2 about here

Slovic, Flynn, and Layman[38] and Slovic, Layman, Kraus, Flynn, Chalmers, and Gesell[39] studied the relationship between affect and perceived risk for hazards related to nuclear power.

For example, Slovic, Flynn, and Layman asked respondents "What is the first thought or image that comes to mind when you hear the phrase 'nuclear waste repository?'" After providing up to three associations to the repository stimulus, each respondent rated the affective quality of these associations on a five-point scale, ranging from extremely negative to extremely positive.

Although most of the images that people evoke when asked to think about nuclear power or nuclear waste are affectively negative (e.g., death, destruction, war, catastrophe), some are positive (e.g., abundant electricity and the benefits it brings). The affective values of these positive and negative images appear to sum in a way that is predictive of our attitudes, perceptions, and behaviors. If the balance is positive, we respond favorably; if it is negative, we respond unfavorably. For example, the affective quality of a person's associations to a nuclear waste repository was found to be related to whether the person would vote for or against a referendum on a nuclear waste repository and to their judgments regarding the risk of a repository accident. For example, more than 90% of those people whose first image was judged very negative said that they would vote against a repository in Nevada; fewer than 50% of those people whose first image was positive said they would vote against the repository.[38]

Using data from the national survey of 1,500 Americans described earlier, Peters and Slovic[34] found that the affective ratings of associations to the stimulus "nuclear power" were highly predictive of responses to the question: "If your community was faced with a shortage of electricity, do you agree or disagree that a new nuclear power plant should be built to supply that electricity?" Among the 25% of respondents with the most positive associations to nuclear power, 69% agreed to building a new plant. Among the 25% of respondents with the most negative associations, only 13% agreed.

3.4 Worldviews, Affect, and Toxicology

Affect and worldviews seem to influence the risk-related judgments of scientists, as well as laypersons. Evidence for this comes from studies of "intuitive toxicology" that Torbjörn Malmfors, Nancy Neil, Iain Purchase, and I have been conducting in the United States, Canada, and the UK during the past eight years. These studies have surveyed both toxicologists and laypersons about a wide range of concepts relating to risks from chemicals. We have examined judgments about the effects of chemical concentration, dose, and exposure on risk. We have also questioned our respondents about the value of animal studies for predicting the effects of chemicals on humans. Before showing how worldviews and affect enter into toxicologists' judgments, a brief description of some basic results will be presented.

Consider two survey items that we have studied repeatedly. One is statement S_1: "Would you agree or disagree that the way an animal reacts to a chemical is a reliable predictor of how a human would react to it?" The second statement, S_2, is a little more specific: "If a scientific study produces evidence that a chemical causes cancer in animals, then we can be reasonably sure that the chemical will cause cancer in humans."

When members of the American and Canadian public responded to these items, they showed moderate agreement with S_1; about half the people agreed and half disagreed that animal tests were reliable predictors of human reactions to chemicals. However, in response to S_2, which stated that the animal study found evidence of cancer, there was a jump in agreement to about 70% among both male and female respondents (see Figure 3). The important point about the pattern of response is that agreement was higher on the second item.

Insert Figure 3 about here

What happens if toxicologists are asked about these two statements? Figure 4 shows that toxicologists in the United States and toxicologists in the UK responded similarly to the public on the first statement but differently on the second. They exhibited the same rather middling level of

agreement with the general statement about animal studies as predictors of human health effects.[1] However, when these studies were said to find evidence of carcinogenicity in animals, then the toxicologists were less likely to agree that the results could be extrapolated to humans. Thus, the same findings which lead toxicologists to be less willing to generalize to humans lead the public to see the chemical as more dangerous for humans.[2]

Insert Figure 4 about here

Figure 5 presents the responses for S_1 and S_2 among men and women toxicologists in the UK (208 men and 92 women). Here we see another interesting finding. The men agree less on the second statement than on the first, but the women agree more, just like the general public. Women toxicologists are more willing than men to say that if a chemical causes cancer in animals, it will likely cause cancer in humans.

Insert Figure 5 about here

We also examined the relative agreement with Statements S_1 and S_2 for each of the British toxicologists in our survey. Greater agreement with S_2 than with S_1 was associated with:

- higher mean perceptions of risk across 25 hazards (the risk-perception index),
- rating pesticides and industrial chemicals as "bad" on a task in which various items were rated on a scale ranging from good to bad,
- being female,
- being younger,
- agreeing that "I have little control over risks to my health."
- holding an academic position rather than a position in industry,
- disagreeing that "technology is important for social well-being," and
- disagreeing that "economic growth is necessary for good quality of life."

These studies of intuitive toxicology have yielded a number of intriguing findings. One is the low percentage of agreement that animal studies can predict human health effects. Another is that toxicologists show even less confidence in studies that find cancer in animals resulting from chemical exposure. The public, on the other hand, has high confidence in animal studies that find cancer. Disagreements among toxicologists are systematically linked to gender, affiliation (academic vs. other), worldviews, and affect. Thus affective and sociopolitical factors appear to influence scientists' risk evaluations in much the same way as they influence the public's perceptions.[3]

4.0 THE IMPORTANCE OF TRUST

The research described above has painted a portrait of risk perception influenced by the interplay of psychological, social, and political factors. Members of the public and experts can disagree about risk because they define risk differently, have different worldviews, different affective experiences and reactions, or different social status. Another reason why the public often rejects scientists' risk assessments is lack of trust. Trust in risk management, like risk perception, has been found to correlate with gender, race, worldviews, and affect.

Social relationships of all types, including risk management, rely heavily on trust. Indeed, much of the contentiousness that has been observed in the risk-management arena has been attributed to a climate of distrust that exists between the public, industry, and risk-management professionals (e.g., Refs. No. 38 and 42). The limited effectiveness of risk-communication efforts can be attributed to the lack of trust. If you trust the risk manager, communication is relatively easy. If trust is lacking, no form or process of communication will be satisfactory.(43)

4.1 How Trust Is Created and Destroyed

One of the most fundamental qualities of trust has been known for ages. Trust is fragile. It is typically created rather slowly, but it can be destroyed in an instant—by a single mishap or

mistake. Thus, once trust is lost, it may take a long time to rebuild it to its former state. In some instances, lost trust may never be regained. Abraham Lincoln understood this quality. In a letter to Alexander McClure, he observed: "If you once forfeit the confidence of your fellow citizens, you can never regain their respect and esteem" [italics added].

The fact that trust is easier to destroy than to create reflects certain fundamental mechanisms of human psychology called here "the asymmetry principle." When it comes to winning trust, the playing field is not level. It is tilted toward distrust, for each of the following reasons:

1. Negative (trust-destroying) events are more visible or noticeable than positive (trust-building) events. Negative events often take the form of specific, well-defined incidents such as accidents, lies, discoveries of errors, or other mismanagement. Positive events, while sometimes visible, more often are fuzzy or indistinct. For example, how many positive events are represented by the safe operation of a nuclear power plant for one day? Is this one event? dozens of events? hundreds? There is no precise answer. When events are invisible or poorly defined, they carry little or no weight in shaping our attitudes and opinions.

2. When events are well-defined and do come to our attention, negative (trust-destroying) events carry much greater weight than positive events.(42)

3. Adding fuel to the fire of asymmetry is yet another idiosyncrasy of human psychology—sources of bad (trust-destroying) news tend to be seen as more credible than sources of good news. The findings reported in Section 3.4 regarding "intuitive toxicology" illustrate this point. In general, confidence in the validity of animal studies is not particularly high. However, when told that a study has found that a chemical is carcinogenic in animals, members of the public express considerable confidence in the validity of this study for predicting health effects in humans.[4]

4. Another important psychological tendency is that distrust, once initiated, tends to reinforce and perpetuate distrust. Distrust tends to inhibit the kinds of personal contacts and experiences that are necessary to overcome distrust. By avoiding others whose motives or actions we distrust, we never get to see that these people are competent, well-meaning, and trustworthy.

4.2 The System Destroys Trust

Thus far we have been discussing the psychological tendencies that create and reinforce distrust in situations of risk. Appreciation of those psychological principles leads us toward a new perspective on risk perception, trust, and conflict. Conflicts and controversies surrounding risk management are not due to public irrationality or ignorance but, instead, can be seen as expected side effects of these psychological tendencies, interacting with a highly participatory Democratic system of government and amplified by certain powerful technological and social changes in society. Technological change has given the electronic and print media the capability (effectively utilized) of informing us of news from all over the world—often right as it happens. Moreover, just as individuals give greater weight and attention to negative events, so do the news media. Much of what the media reports is bad (trust-destroying) news.[44–45]

A second important change, a social phenomenon, is the rise of powerful special interest groups, well funded (by a fearful public) and sophisticated in using their own experts and the media to communicate their concerns and their distrust to the public to influence risk policy debates and decisions.[46] The social problem is compounded by the fact that we tend to manage our risks within an adversarial legal system that pits expert against expert, contradicting each other's risk assessments and further destroying the public trust.

The young science of risk assessment is too fragile, too indirect, to prevail in such a hostile atmosphere. Scientific analysis of risks cannot allay our fears of low-probability catastrophes or delayed cancers unless we trust the system. In the absence of trust, science (and

risk assessment) can only feed public concerns, by uncovering more bad news. A single study demonstrating an association between exposure to chemicals or radiation and some adverse health effect cannot easily be offset by numerous studies failing to find such an association. Thus, for example, the more studies that are conducted looking for effects of electric and magnetic fields or other difficult-to-evaluate hazards, the more likely it is that these studies will increase public concerns, even if the majority of these studies fail to find any association with ill health.[47–48] In short, because evidence for lack of risk often carries little weight, risk-assessment studies tend to increase perceived risk.

5.0 RESOLVING RISK CONFLICTS: WHERE DO WE GO FROM HERE?

5.1 Technical Solutions to Risk Conflicts

There has been no shortage of high-level attention given to the risk conflicts described above. One prominent proposal by Justice Stephen Breyer[49] attempts to break what he sees as a vicious circle of public perception, congressional overreaction, and conservative regulation that leads to obsessive and costly preoccupation with reducing negligible risks as well as to inconsistent standards among health and safety programs. Breyer sees public misperceptions of risk and low levels of mathematical understanding at the core of excessive regulatory response. His proposed solution is to create a small centralized administrative group charged with creating uniformity and rationality in highly technical areas of risk management. This group would be staffed by civil servants with experience in health and environmental agencies, Congress, and the Office of Management and Budget (OMB). A parallel is drawn between this group and the prestigious Conseil d'Etat in France.

Similar frustration with the costs of meeting public demands led the 104th Congress to introduce numerous bills designed to require all major new regulations to be justified by extensive risk assessments. Proponents of this legislation argue that such measures are necessary to ensure

that regulations are based on "sound science" and effectively reduce significant risks at reasonable costs.

The language of this proposed legislation reflects the traditional narrow view of risk and risk assessment based "only on the best reasonably available scientific data and scientific understanding." Agencies are further directed to develop a systematic program for external peer review using "expert bodies" or "other devices comprised of participants selected on the basis of their expertise relevant to the sciences involved" (Ref. No. 50, pp. 57–58). Public participation in this process is advocated, but no mechanisms for this are specified.

The proposals by Breyer and the 104th Congress are typical in their call for more and better technical analysis and expert oversight to rationalize risk management. There is no doubt that technical analysis is vital for making risk decisions better informed, more consistent, and more accountable. However, value conflicts and pervasive distrust in risk management cannot easily be reduced by technical analysis. Trying to address risk controversies primarily with more science is, in fact, likely to exacerbate conflict.

5.2 Process-Oriented Solutions

A major objective of this paper has been to demonstrate the complexity of risk and its assessment. To summarize the earlier discussions, danger is real, but risk is socially constructed. Risk assessment is inherently subjective and represents a blending of science and judgment with important psychological, social, cultural, and political factors. Finally, our social and democratic institutions, remarkable as they are in many respects, breed distrust in the risk arena.

Whoever controls the definition of risk controls the rational solution to the problem at hand. If you define risk one way, then one option will rise to the top as the most cost-effective or the safest or the best. If you define it another way, perhaps incorporating qualitative

characteristics and other contextual factors, you will likely get a different ordering of your action solutions.[51] Defining risk is thus an exercise in power.

Scientific literacy and public education are important, but they are not central to risk controversies. The public is not irrational. The public is influenced by emotion and affect in a way that is both simple and sophisticated. So are scientists. The public is influenced by worldviews, ideologies, and values. So are scientists, particularly when they are working at the limits of their expertise.

The limitations of risk science, the importance and difficulty of maintaining trust, and the subjective and contextual nature of the risk game point to the need for a new approach—one that focuses on introducing more public participation into both risk assessment and risk decision making to make the decision process more democratic, improve the relevance and quality of technical analysis, and increase the legitimacy and public acceptance of the resulting decisions. Work by scholars and practitioners in Europe and North America has begun to lay the foundations for improved methods of public participation within deliberative decision processes that include negotiation, mediation, oversight committees, and other forms of public involvement.[52–56]

Recognizing interested and affected citizens as legitimate partners in the exercise of risk assessment is no short-term panacea for the problems of risk management. It won't be easy and it isn't guaranteed. But serious attention to participation and process issues may, in the long run, lead to more satisfying and successful ways to manage risk.

Acknowledgement

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Table I. Some Ways of Expressing Mortality Risks

Deaths per million people in the population
Deaths per million people within x miles of the source of exposure
Deaths per unit of concentration
Deaths per facility
Deaths per ton of air toxic released
Deaths per ton of air toxic absorbed by people
Deaths per ton of chemical produced
Deaths per million dollars of product produced
Loss of life expectancy associated with exposure to the hazard

Table II. Percentage Of People Who Agreed To Support a New Nuclear Power Plant in Their Community[a]

	Agreement with the worldview question			
	Strongly disagree	Disagree		
Individualism worldview:				
In a fair system people with more ability should earn more	37.5%	37.7%	47.2%	53.4%
Egalitarian worldview:				
What this world needs is a more equal distribution of wealth	73.9%	53.7	43.8	33.8

[a]The exact question was: "If your community was faced with a potential shortage of electricity, do you agree or disagree that a new nuclear power plant should be built to supply that electricity?" The cell entries in this table show the percentage of people who agreed with this statement conditioned by whether they agreed or disagreed with questions about individualism and egalitarianism.

Figure Captions

Figure 1. Mean risk-perception ratings by race and gender. Source: Ref. No. 28.

Figure 2. Model showing how information about benefit (A) or information about risk (B) could create a more positive affective evaluation of nuclear power and lead to inferences about risk and benefit that are affectively congruent with the information input. Similarly, information could decrease the affective evaluation of nuclear power as in C and D, resulting in inferences that are opposite those in A and B. Source: Ref. No. 37.

Figure 3. Agreement among members of the public in the United States for Statements S_1 and S_2. Source: Ref. No. 40.

Figure 4. Agreement with two statements, S_1 and S_2, regarding the extrapolation of chemical effects in animals to chemical effects in humans. Source: Ref. No. 41.

Figure 5. Agreement of men and women toxicologists in the United Kingdom with two statements regarding extrapolation of chemical effects in animals to chemical effects in humans. Source: Ref. No. 41.

Insert Figure 1 here

Insert Figure 2 here

Insert Figure 3 here

Insert Figure 4 here

Insert Figure 5 here

NOTES

1. This is actually a very surprising result, given the heavy reliance on animal studies in toxicology.

2. This pattern suggests that animal studies may be scaring the public without informing science.

3. Although we have focused only on the relationship between toxicologists' reaction to chemicals and their responses to S_1 and S_2, there were may other links between affect and attitudes in the survey. For example, the very simple bad-good ratings of pesticides correlated significantly ($\underline{r}$ = .20) with agreement that there is a threshold dose for nongenotoxic carcinogens. The same ratings correlated –.27 with the belief that synergistic effects of chemicals cause animal studies of single chemicals to underestimate risk to humans

4. Further evidence supporting this point comes from a representative sample of the U.S. public surveyed by the author and his colleagues in 1998. Whereas 61% agreed with the general statement about the reliability of animal tests, 72% agreed with S_2, the statement about a test that gave bad news. In response to a new question (S_3) giving good news ("the scientific studies found no evidence that the chemical causes cancer in animals"), only 43% agreed that this enabled us to be reasonably sure the chemical does not cause cancer in humans.

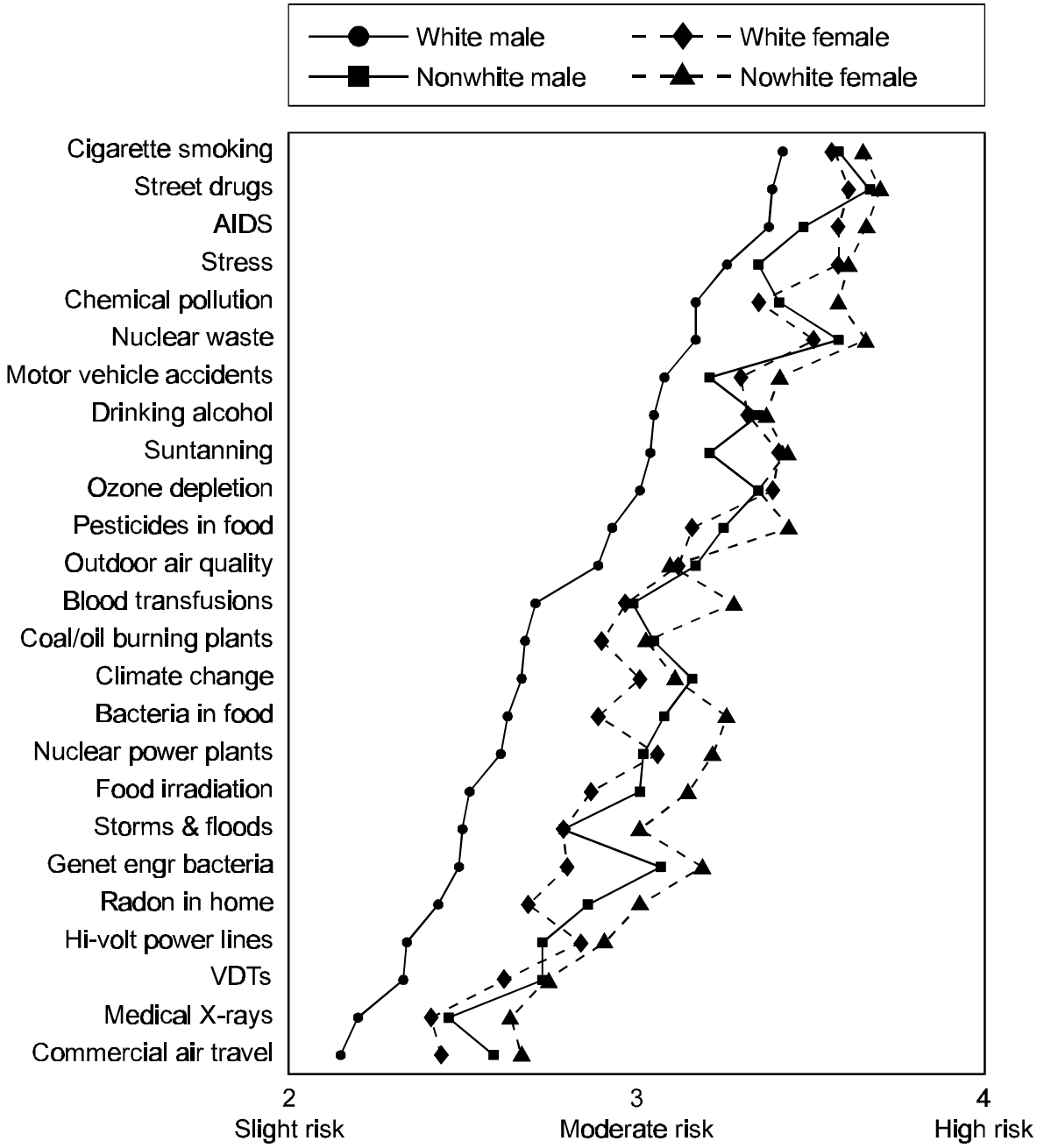
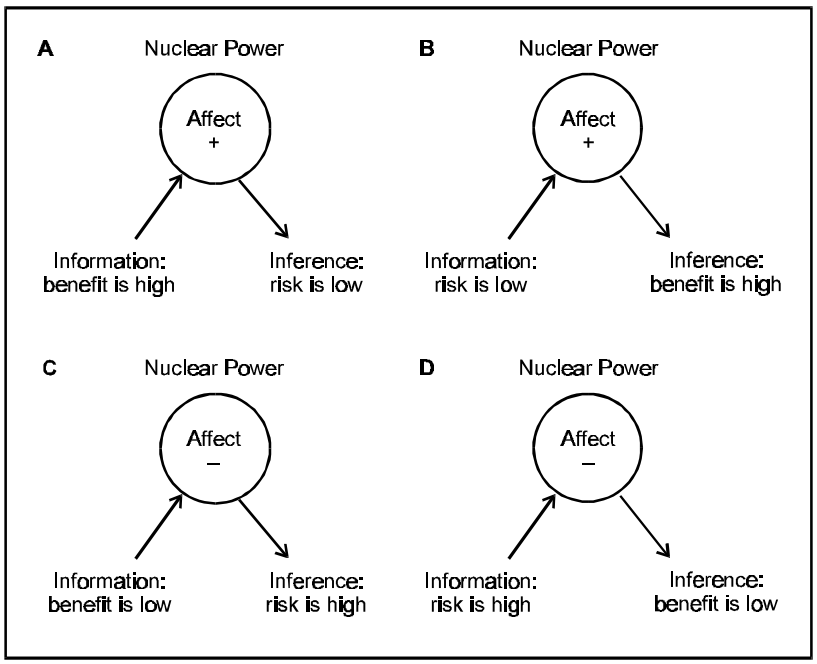


Figure 1. Mean risk-perception ratings by race and gender. Source: Ref. No. 28.



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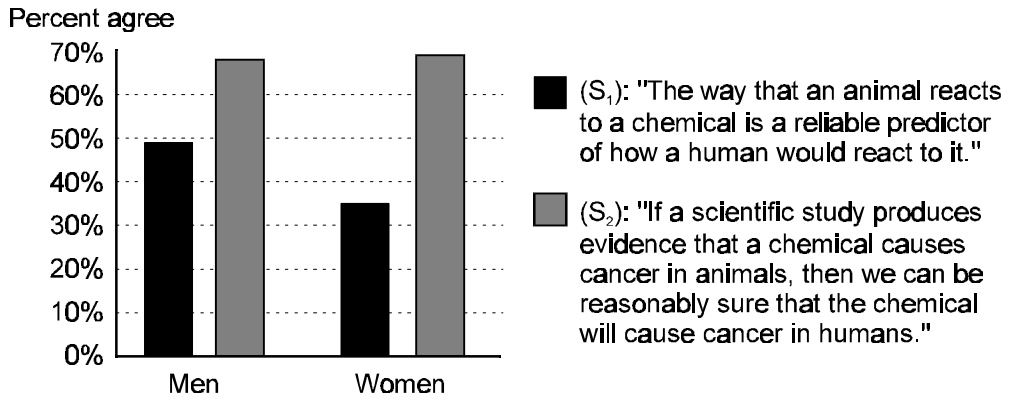


Figure 3. Agreement among members of the public in the United States for Statements S_1 and S_2. Source: Ref. No. 40.

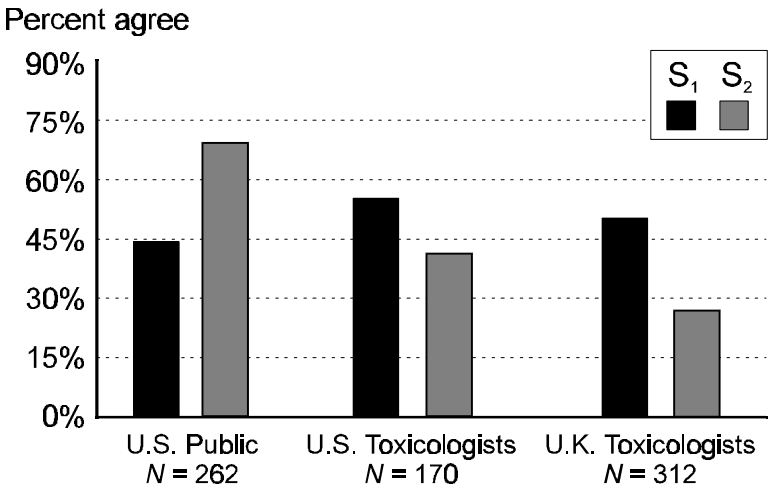
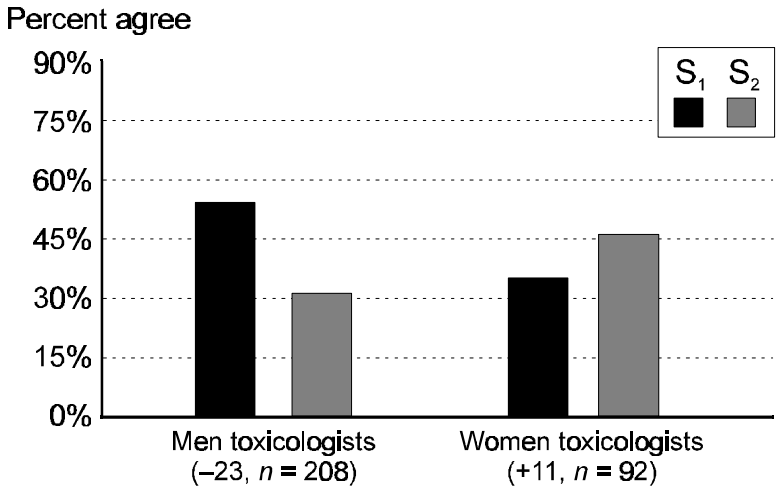


Figure 4. Agreement with two statements, S_1 and S_2, regarding the extrapolation of chemical effects in animals to chemical effects in humans. Source: Ref. No. 41.



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