Risk Analysis, Vol. 20, No. 1, 2000

Factors in Risk Perception

Lennart Sjöberg[1]

Risk perception is a phenomenon in search of an explanation. Several approaches are discussed in this paper. Technical risk estimates are sometimes a potent factor in accounting for perceived risk, but in many important applications it is not. Heuristics and biases, mainly availability, account for only a minor portion of risk perception, and media contents have not been clearly implicated in risk perception. The psychometric model is probably the leading contender in the field, but its explanatory value is only around 20% of the variance of raw data. Adding a factor of "unnatural risk" considerably improves the psychometric model. Cultural Theory, on the other hand, has not been able to explain more than 5–10% of the variance of perceived risk, and other value scales have similarly failed. A model is proposed in which attitude, risk sensitivity, and specific fear are used as explanatory variables; this model seems to explain well over 30–40% of the variance and is thus more promising than previous approaches. The model offers a different type of psychological explanation of risk perception, and it has many implications, e.g., a different approach to the relationship between attitude and perceived risk, as compared with the usual cognitive analysis of attitude.

KEY WORDS: Risk perception; cultural theory; psychometric paradigm

1. INTRODUCTION

Perceived risk has been a focus of interest of policymakers and researchers for some decades. Risk perception appears to hold a central position in the political agenda of many countries and is crucial for the understanding of involvement in the environment and opposition to technology.[1,2] For example, a study of private bills submitted to the Swedish Parliament showed that the share of risk-related bills had tripled during the last 30 years, from 11 to 29%.[3] Risk perception is an especially important aspect in the nuclear field. The present paper addresses the question: Why do people perceive risks as they do?

The beginning of risk perception research can be traced to the nuclear debate of the 60s. Sowby[4] had devised risk comparisons which for a while were believed to be pertinent for risk communication. However, Starr soon followed and showed that risk acceptance was related not only to technical estimates of risk and benefits but also to a subjective dimension such as voluntariness.[5] Although Starr's choice of data bases was criticized[6] his work was very seminal in opening up a new area of research. The question of perceived risk had thus been posed, and social scientists rose to the challenge of explaining this curious phenomenon.

2. TECHNICAL ESTIMATES OF RISK

Several factors have been proposed for the explanation of perceived risk. A primary candidate is, of course, real risk. Although risk is always construed, real risk is a useful concept for expertly, or otherwise well-founded, assessed risk. Most authors have tended to downplay this factor, for various reasons. Still, some studies suggest that real risk is a very important determinant of perceived risk in some contexts. For example, in a well-known paper[7] it was shown that average

[1] Stockholm School of Economics, Center for Risk Research, Box 6501, 11383 Stockholm, Sweden.

0272-4332/00/0200-0001$16.00/1

estimated mortality rates for a number of common illnesses and accidents were strongly related to statistical data. There was also, to be sure, some systematic deviation from the trend—small risks were overestimated and large risks were underestimated—but the general trend was the one just stated: risks were perceived, by the average person, in a rather veridical manner. Others[8,9] have replicated these findings.

The type of risks where realistic perception can be expected appear to be the risks with which people have some experience, direct or indirect.[10] In addition, it must be noted that the risk ratings of the cited work concerned *general* risk, i.e., the risk to others, or to people in general. The risk target is a factor of great importance in risk perception, to be treated in a subsequent section.

3. HEURISTICS, BIASES, AND RISK PERCEPTION

Whether people perceive a risk the same as technical risk estimates can be seen as a question of the veridicality of subjective probability. It was conceived in that way in the 1970s, and the work on heuristics and probability judgment biases[11] was often cited as pertinent.[12] Of the three heuristics—representativeness, availability, and anchoring—it was most often argued that availability[13] was important for understanding risk perception. There is an obvious relationship here to mass media and the idea that frequent media exposure gives rise to a high level of perceived risk.[14]

This work is no longer regarded as of primary importance for risk perception, however. Fischhoff and others showed early on that the public's risk perception was much more multidimensional—subjective probability is only one of many factors.[15] The mass media role in risk perception is still very much under debate.[16,17]

The heuristics tradition relied heavily on a presumption that belief distortion is a matter of cognition. It has been found, however, that beliefs and values correlate strongly.[18,19] This phenomenon is hard to account for in a purely cognitive framework, and it suggests that beliefs are value driven. The bias of beliefs is largely a question of a tendency towards black-and-white construals and wishful thinking. Montgomery pointed to the pervasive tendency of decision makers to construe options in such a manner as to obtain a dominant or quasi-dominant alternative; the choice of such an alternative is of course very easily justified to oneself and others.[20]

It can be added that the work on heuristics relied greatly on probability calculus problems that had been set up to have counterintuitive answers. However interesting such a method may be for revealing how intuition differs from probability calculus, it has probably limited applicability to how people perceive probabilities and risks in applied settings.

4. RISK TARGET

People do not make the same estimate when they rate the risk to themselves, to their family, or to people in general. For example, in a study with a large representative sample of the Swedish population, these three risk targets were studied for a set of fifteen hazards.[21] The respondents were instructed to rate the risks on a scale from 0 (no risk at all) to 6 (an extremely large risk), with five categories lying in between these two extremes and defined as 1, 2, 3, 4, and 5. The mean ratings (N = 1,224, 72% response rate) are given in Fig. 1. Drastic differences are seen, particularly between general risk and personal or family risk.

Note that the difference is not only a question of level. The rank order between risks is not the same across targets.

It is clear that not everybody can be right in saying that he or she is subjected to a smaller risk than people in general (even if some respondents of course are right in saying so). The fact that people most often claim to be less subjected to risk than others can be termed risk denial. Risk denial is a very important feature of risk perception. The phenomenon is related to what has been called unrealistic optimism.[22]

It is also important, of course, to ask what can cause this variation in perceived risk across risk targets. Respondents have also been asked to rate the

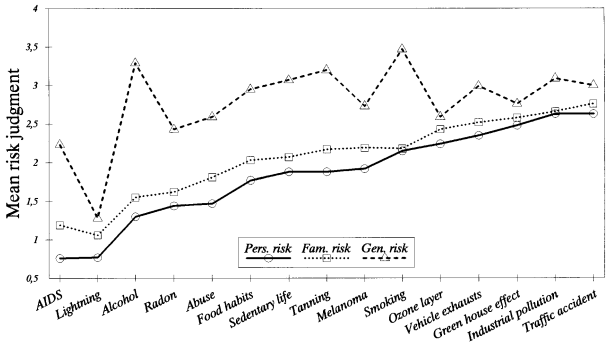

Fig. 1. Average risk ratings: personal, family, and general risk.

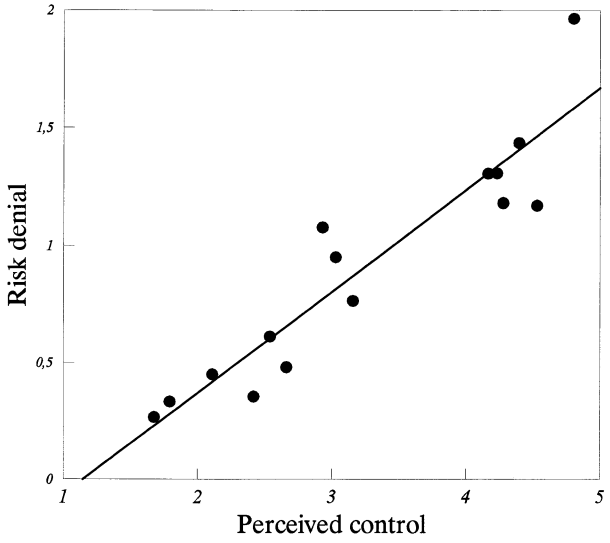

Fig. 2. Risk denial (general minus personal risk) plotted against perceived control over risks. Each point corresponds to one hazard; mean ratings are plotted.

degree of control they felt they had over each of the hazards—to what extent they could protect themselves against it.[23] Mean differences between general and personal risk (risk denial) are plotted in Fig. 2 against mean control ratings.

Hence, at this level of analysis, control is apparently an important variable in accounting for risk denial. For individual data, the correlation is much weaker.

In many risk perception studies the target is not explicitly spelled out. The respondents are simply asked to rate "the risk," with no further specification. That instruction was compared with several others in a study of 309 subjects who were divided at random into groups getting different instructions.[24] They rated 27 hazards. The results are seen in Fig. 3.

It was found that the no-target condition gave about the same result as rating the general risk. Furthermore, rating the risk to "any one person" also gave the same result, refuting the sometimes-heard explanation of the general–personal difference that it reflects the fact that general risk ratings refer to many more persons than personal risk ratings.

Personal risk and general risk have different consequences. Consider, by way of illustration, a study of attitudes to alcohol sales liberalization in Sweden.[2]

[2] At present, alcoholic beverages can be sold only by state monopoly stores, which are rather few and keep quite restricted business hours. Taxation keeps prices very high. The system has been in place since the 1950s, when it replaced a still more restrictive system.

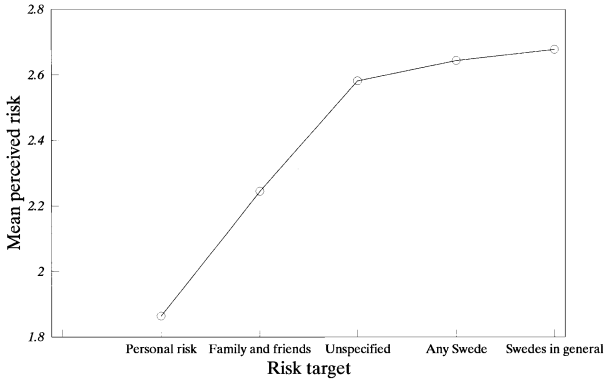

Fig. 3. Mean ratings of 27 hazards plotted for different targets; independent groups rated each target.

An unpublished master's thesis from the Center for Risk Research reported a study of perceived risk and the attitude to legislation enabling ordinary grocery stores to sell wine.[25] The correlations between perceived personal risk of alcohol-caused injury and the corresponding general risk on the one hand and attitude toward liberalization of sales on the other were −0.59 for general risk and −0.15 for personal risk. (In both cases, a larger risk was associated with a more negative attitude.) Hence, policy attitude was probably driven by general risk rather than personal risk.

The risk target is of paramount importance in risk studies. This fairly simple fact seems not to be generally known and many studies still work with nonspecified risk targets. This means that they probably miss out on the need to understand perceived personal risk, and it introduces some uncertainty as to what target they actually do study. Some authors argue explicitly against the introduction of a target and seem to regard the choice by the subject as to target as an interesting factor.[26] Although it is true that studying the choice of target in a situation with ambiguous or nonspecific instruction as to target could be interesting, this is simply not possible in a design where people just make nonspecific risk ratings. Additional information about the choice of target, not collected in Marris *et al.*,[26] is needed.

5. THE PSYCHOMETRIC MODEL

This model was launched in a 1978 paper by Fischhoff *et al.*[27] The empirical work reported in that paper was later followed up with several other studies that were more extensive, both in terms of scales and the number of respondents.

The model is based on a number of explanatory scales (9 to begin with, later 18) such as New–Old, Voluntary–Involuntary, etc. The subjects are asked to rate a number of hazards on each of the scales. Mean ratings are computed for each hazard on each scale, and the resultant Scales × Hazards matrix is factor analyzed. Usually, three factors suffice to explain a large share of the variance, perhaps around 80%. The factors that have been found in many studies are New–Old, Dread, and Number of Exposed.

The scales, or the factors, usually account for some 60–70% of the variance of perceived risk or risk acceptance, when entered as average ratings for a number of hazards in multiple regression analyses.

This model has been used as a basis for extensive work on risk communication.[28] The famous "map" of hazards in the two major dimensions of Dread and New–Old[29] shows, e.g., how nuclear power is located in a position where it is highly loaded on the Dread dimension and also seen as New or Unknown. This finding apparently seemed to be a self-evident explanation of the strong public opposition to nuclear power and is still often quoted as such.

This is curious indeed because no data actually linked opposition to nuclear power to the psychometric dimensions. Apparently it was sufficient that it just seemed to be the explanation. As a counterexample, the perceived risk of nuclear waste in Swedish data is accounted for neither by dread nor newness.[30] Indeed, nuclear power is not perceived as "new." Perhaps the 15 years since the first U.S. studies account for that. But *opposition* to nuclear power is ever present today, just as it was at the end of the 1970s. One wonders just how important the factor of newness is, or was.

Furthermore, the model is not at all so powerful as its proponents have claimed. Several reasons for this statements can be given:

1. Factor analysis of a matrix with only 9 or even 18 scales is bound to give few factors. The fact that these few factors account for some 80% of the variance of the scales is not surprising and does not at all imply that they can also account for the perceived level of risk to same extent. The latter factor could be unrelated to the scales, and the scales could still be well described by 3 factors.

2. The scales were based on a compilation of factors suggested in the earlier risk literature of the 70s, which in turn was stimulated by Starr's work.[5] Although 18 scales may seem like a lot, they missed at least one important aspect, namely, interference with nature (tampering with nature, immoral and unnatural risk), which will be further described subsequently.

3. The finding that a very large share of the variance of perceived risk could be explained by these factors is due to the fact that the authors analyzed mean ratings, not raw data.[31] Mean data are less subject to error than raw data and "smooth," hence models of various kinds are much more likely to fit. One could, of course, claim that mean risk ratings are the focus of interest, not raw data, which reflect more directly the risks actually perceived by the subjects. However, for practical and theoretical purposes it would seem to be obvious that the individual ratings should be of primary interest. The analysis of behavior should not be of average behavior but of the ratings that people actually give. And for a practitioner, the inflated levels of explanatory power given by the results reported for the analyses of means simply are very misleading. The raw data can only be explained to about 20–30% by the traditional psychometric model,[32,33] and this means that many other factors are just as important as, or more important than, the psychometric factors devised by Fischhoff *et al.*[27]

For one such dimension, consider results showing that a fourth factor, denoted as Unnatural and Immoral Risk, has been discovered in recent work.[34] This work is a continuation of earlier studies in which the moral factor was emphasized[35,36] and shown to be strongly related to perceived risk. Morality is indeed missing from much of the work on risk perception,[37] and the reason might be that hazards are conceived as such, rather than as the outcome of human actions.

In a study of perceived nuclear waste, risk data were obtained from a representative sample of the Swedish population, response rate 53.2% (N = 541).[34] A factor analysis of 21 psychometric scales applied to nuclear waste risk gave a four-factor solution with 66% explained variance. Oblimin rotation resulted in four factors, three of which were traditional, namely New Risk, Dreaded Risk, and Number of Exposed. A fourth factor also emerged, loaded in such items as Unnatural Risk, Immoral Risk, and Human Arrogance. A multiple regression of perceived nuclear waste risk (a pooled index, no target specified) against these four factors gave the results shown in Table I.

Only the factor of Unnatural and Immoral Risk had a significant β value. Note that the psychometric model performed, in its three-factor version, at the usual 20% level and that its performance was strongly improved by the introduction of the new

Table I. Multiple Regression Analysis of Perceived Nuclear Waste Risk as a Function of Psychometric Explanatory Factors

Explanatory variable	β Value (four factor model)
Many exposed to risk	0.090
New risk	0.044
Unnatural and immoral risk	0.452
Dreaded risk	−0.006
R^2_{adj} three traditional factors	0.200
R^2_{adj} four factors	0.280

fourth factor, which then carried the whole of its explanatory power.

Could these findings be replicated in a different setting and with different hazards? Another set of data analyzed here are from a current European Union project called RISKPERCOM in which 798 respondents (response rate 61.0%), representative of the Swedish population, answered an extensive risk perception questionnaire. Results are given for personal and general risk of domestic nuclear power and factor scores of four factors (explaining 61% for the variance) of psychometric scales measuring the perception of a Chernobyl-type accident. Twenty-two scales were once more compressed to four factors: New Risk, Dreaded Risk, Many Exposed, and Unnatural and Immoral Risk (including risk as a warning of worse to come). The results are given in Table II. The reason for the rather low values of R^2_{adj} is probably that a rather specific psychometric target was studied, namely "A Chernobyl-type accident."

The conclusion drawn about the psychometric model is that, in its traditional three-factor form, it explains only a rather modest share of the variance of perceived risk. The widespread credibility that the model apparently enjoys seems to be based largely on the fact that analysis was done on averages rather than raw data, i.e., correlations reported were based on means and therefore very high, thereby giving an impression that virtually all of risk perception was accounted for.

Table II. Regression Analyses of Personal and General Risk of Domestic Nuclear Power as a Function of Four Psychometric Factors, and R^2_{adj} for the Three Traditional Factors

	β Value	
	Personal risk	General risk
Many exposed to risk	0.016	0.054
New risk	0.000	−0.013
Unnatural and immoral risk	0.436	0.419
Dreaded risk	0.014	0.000
R^2_{adj} three traditional factors	0.086	0.094
R^2_{adj} four factors	0.199	0.198

The fourth factor throws quite a different light on perceived nuclear risk than the three traditional factors. It is no longer a question of new or dreaded risk, but a more elaborated perspective having to do with notions about tampering with nature and moral questions. Other current concerns such as genetic engineering and the BSE ("mad cow disease") come easily to mind in this connection and the fourth factor therefore seems worthy of serious consideration in further risk perception work.

It is sometimes argued that scales of the psychometric type are trivially related to risk perception and that semantic overlap is the true reason for success in accounting for risk perception. Items that have the same or very similar denotation can of course be expected to correlate quite strongly. In the present context, however, this argument is exaggerated. Level of perceived risk is not strictly semantically overlapping with, say, newness or immorality of a hazard. The fact that properties of a construct or object are statistically related to a global assessment such as attitude or level of risk may be seen as likely but is not an artifact. Yet, many researchers voice their interest in more "distal" explanations of risk, i.e., in constructs that are contentwise less obviously related. A second major attempt at explaining risk perception is provided by Cultural Theory, and that theory tries to deliver such nonproximal explanatory concepts of risk perception. A discussion of that theory and some related approaches of a distal nature follows.

6. CULTURAL THEORY OF RISK PERCEPTION

The Cultural Theory of risk perception was spelled out in a book by Douglas and Wildavsky[38] and made operational for quantitative study by Dake.[39,40] The theory specifies that there are four types of people: egalitarian, individualistic, hierarchic, and fatalistic. These types of people will "choose" to be concerned with different types of hazards:

- *Egalitarians*: technology and the environment
- *Individualists*: war and other threats to the markets
- *Hierarchists*: law and order
- *Fatalists*: with none of the above

These four types of people were originally suggested by a group-grid analysis. The potent social context—in an abstract and formal sense—of a person is assumed to be governing his or her beliefs. A full empirical and quantitative investigation of the theory demands a study also of these social phenomena—no such investigation has so far been published.

The theory is a rich conceptual structure and has several variations; see Boholm's critical analysis of the theory from the standpoint of an anthropologist.[41] Boholm's conclusions as to the theoretical status of the theory are quite negative. The present paper will concentrate on what can be said about the empirical support claimed for the theory in quantitative studies of the relationship between the four types of people noted previously and risk perception. A fuller discussion is available elsewhere.[42]

First, however, a few words about theory. The success of Cultural Theory is largely an example of the persuasive power of speculation. The theory has now existed for some 15 years and it has been, in the words of a supporter, "immensely influential."[43] Yet, the only empirical evidence offered before Dake's work was available in anecdotal accounts, a few anthropological observations, and some observations using more or less informal qualitative methods.

The initial empirical support for the theory was described by Wildavsky and Dake.[44] They used scales measuring the four concepts illustrated by the types noted previously and variously termed cultural biases or world views. The scale scores were correlated with a number of "social concerns,"[3] which can perhaps be seen as a kind of risk ratings, and reports were given for a selection of the concerns that were significantly correlated with the scales. The pattern of relationships provided by these correlations was roughly in accordance with predictions from the theory, but only bivariate correlations were given, so judging how much of the variance of perceived concerns would have been explained by multiple regression of the scale scores is impossible.

However, the same scales and concerns were investigated in a later study of U.S. subjects by Sjöberg,[45] in which explicit risk ratings were also obtained. It was found that concerns were explained, on average, to about 10% of the variance, risk ratings to only half as much. European studies, using a revised form of the scales, have shown that the scales account for about 5% of the variance, on average.[46:26] Correlations with single items have turned out to give a very low amount of explained variance when added to other explanatory constructs in models of risk perception.[37,47]

Yet the pattern of relationships with social concerns observed by Dake is apparently robust.[26,45] The question is what to conclude from that finding of a weak but systematic pattern of relationships. Several authors have suggested that much stronger relationships are likely if the scales are improved. However, correcting for measurement error yields only trivial increase of the correlations. (Reliabilities of the U.S. scales are not reported in Dake's work but can be found in Sjöberg.[45] They were moderate.)

The Dake scales are examples of scales of political values and attitudes, and they function much in the same manner as traditional political attitude scales when related to risk perception, i.e., quite weakly.

Asking if value scales *in general* are similarly weak in accounting for risk perception is natural. Sjöberg first approached this question by investigating lifestyle scales and relating them to risk perception.[48] Lifestyles are extremely popular in marketing and there are many claims about their strong explanatory value in various commercial contexts. However, they were found to carry little or no explanatory power for risk perception.

A second approach, investigating some currently popular general value scales in the environmental field, is summarized here. To achieve this purpose, a number of value scales were included in a questionnaire aiming at the measurement of attitudes to Swedish membership in the European Union. The study was conducted during the month before the Swedish referendum (November 13, 1994). A mail survey design was used. Sixty percent of a random sample of the adult Swedish population responded, thus yielding a data set with 1,224 respondents.

Twenty two risks, all personal, were included in the study,[4] and representing a broad selection of threats to health, environment, and economy. They were judged on a category scale with 7 steps, 0–6, where 0 denoted a nonexistent risk and 6 an extremely large risk.

The value scales were Swedish translations of the following:

[3] Although this research has been suggested as strong evidence for a Cultural Theory apporach to understanding opposition to technology, the social concerns actrully studied were mostly related to economic and social problems, not problems of technology.

[4] Personal and general risk perception correlate highly and have similar relationships to other variables, so it is unlikely that general risk perception data would have been more strongly related to value dimensions.

Table III. Mean and Range of Explained Variance of 22 Personal Risks, on the Basis of Background Variables and Value Dimensions

Explanatory variable	Minimum	Maximum	Average
Sex	.000	.042	.011
Education	.000	.030	.007
Size of residential community	.000	.010	.003
Income	.000	.039	.008
Political party preference	.004	.163	.051
Kahle's list of values	.000	.070	.024
Dunlap's New Environmental Paradigm	.010	.104	.046
Inglehart's post-materialism	.001	.095	.038
Schwartz's 14 general items	.017	.129	.067
Schwartz's responsibility items	.001	.093	.026
Schwartz's awareness of consequences items	.000	.260	.058
Kempton items	.000	.088	.035
Left-right political items	.005	.113	.050

1. Kahle's[49,50] List of Values (8 items)
2. Dunlap's New Environmental Paradigm[51] (15 items)
3. Inglehart's[52] postmaterialism items (12 items)
4. Three subsets of items from Schwartz's[53] value scale. These were 14 items selected on the basis of a previous study to cover the factors of the scale in a representative manner, 9 associated with environmental responsibility and 9 with consequences of environmental risks, in all 32 items.
5. Nine items from a study of American values by Kempton[54]
6. Eleven items measuring current left–right conflict or traditional political ideology

Multiple correlations (squared, adjusted) were computed for each set of value items and each perceived personal risk. In addition, R^2_{adj} or eta^2 were computed for the risks and the following background data:

- Sex
- Education
- Income
- Size of residential community
- Political party preference

In Table III, the mean amounts of variance explained, computed across the 22 risks, as well as minimum and maximum values of R^2_{adj} or eta^2 are reported.

These results show clearly that general value dimensions are not very promising for understanding risk perception. Even in the best case, only a modest average of 6–7% of the variance was explained.

It is also important to note that background factors were very weakly related to risk perception. Survey studies often display a bias of some kind, e.g., in terms of educational level of the respondents, but results such as the present ones (and they are rather typical) suggest that such bias is not serious in studies of risk perception.

Several other objections to the critique of Cultural Theory need to be discussed. It should first be noted that the results reported here are not all that different from the ones reported by Dake. The differences are mostly a question of the conclusions drawn, not the results per se.

Defenders of Cultural Theory have suggested a number of objections to the present conclusions, namely that the results are due to restriction of range or differentiation (too few steps) of the variables used, lack of reliability, the choice of risk perception rather than demand for risk mitigation, linguistic difficulties or cultural differences; or it is argued that other ways of making the theory operational could result in research supporting the theory. None of these ad hoc objections holds up under closer scrutiny, however. The purely statistical objections (restriction of range, lack of reliability, etc.) have been checked and found to be of minor importance. The differences in political culture between Europe and the United States may be the reason why the Dake scales are somewhat more strongly related to risk perception in the United States than in Europe.[5] The notion that the theory may be supported in other, as yet untried, ways is logically correct but an uninteresting type of objection

[5] The left in Europe is more strongly associated with the established power and takes responsibility for technologies such as nuclear power. Hence, egalitarian values cannot be expected to be as strongly correlated with antitechnology values as in the United States.

which can always be brought up when a theory fails. For a more detailed discussion, see Sjöberg.[55]

Summing up so far, neither Cultural Theory, values in general nor the psychometric model explain much of risk perception. The latter model accounts, in its original form, for only some 20% of the variance of risk perception. Adding the new dimension Unnatural and Immoral Risk increases that figure substantially but still leaves most of the variance unexplained. Cultural Theory is an even less successful attempt to explain risk perception than the psychometric model. Apparently a new and quite different approach is needed.

7. RISK SENSITIVITY, ATTITUDE, AND SPECIFIC FEAR

Three concepts will be used to model risk perception. Consider first the concept of attitude, or affect. Conventional attitude theory assumes that attitude is a function of beliefs and values.[56] However, an argument can be made for the opposite direction of influence,[57] i.e., for attitude to be driving beliefs. Structural equations modeling[57] supports this notion. In the present context, risk perception would be caused by attitude, e.g., to nuclear power, not the other way around.

Second, consider the concept of risk sensitivity. If a set of risk ratings are correlated it is almost always found that they correlate positively and rather strongly. In turn, this suggests that a common underlying factor is measured by all risk ratings, no matter what type of hazard is being investigated. Two psychological explanations could account for this finding. People could truly differ in risk sensitivity, i.e., some persons are very upset and worried about virtually all hazards, whereas others are quite indifferent and tranquil. Or people could have different scale-use habits. Some tend to use the high end of the scale, for some reason (perhaps linguistic habits), others tend to use the low end of the scale, no matter what hazard they rate. The latter hypothesis is, however, weakened by the fact that correlations between risk ratings and different ratings tend to be low—a finding not compatible with the notion that risk intercorrelations are due to variation between individuals in scale-use habits. For the present model analysis, a risk sensitivity index was used. It was based on a rather large number of ratings of risk of a non-specific kind, i.e., in a study of nuclear risk it would contain risk ratings of nonnuclear and nonradiation hazards.

Third, consider the concept of specific fear. Any hazard elicits thoughts about specific fear-arousing elements. For example, the perceived risk of flying elicits notions about falling from a great height, or burning, or being killed by a violent explosion. Nuclear fear is associated with the specific fear of radiation.

Consider the case of nuclear power and three cases of hazards:

- Nuclear
- Radiation, nonnuclear
- Nonradiation, nonnuclear

The case of radiation and nonnuclear is interesting. It refers to a type of hazard that has an important, specific factor in common with nuclear hazards, namely radiation. Therefore, an index of nonnuclear and radiation-relevant hazards was formed (excluding X-ray diagnostics from this index in the analyses of X-ray perceived risk reported subsequently).

Results from this model for X-ray diagnostics and for domestic nuclear power are presented here. These two cases are quite interesting because they both involve ionizing radiation, but they are still technologies perceived in quite different ways. In Sweden, X-ray diagnostics is viewed in a quite positive manner and nuclear power in a more neutral manner.[34] The data are from the same study as the one investigating the psychometric model and "natural" risk (see previous discussion), with an N of 798. Tables IV and V give the results for personal and general risk, respectively.

It is seen that the three explanatory variables account for a sizeable share of the variance of perceived risk. All β values were highly significant. A further analysis of the specific risk components is called for. The high levels of explained variance reached are encouraging but not high enough to suggest that an exhaustive analysis has been made. Models reaching above 60% explained variance have been presented elsewhere.[30]

Table IV. Regression Analyses of Personal Risk of Domestic Nuclear Power and X-ray Diagnostics, Personal Risk

	β value	
Explanatory variable	Nuclear power	X-ray diagnostics
Attitude	0.403	0.130
Specific radiation risk (nonnuclear)	0.216	0.201
General risk sensitivity (nonnuclear, nonradiation)	0.270	0.354
R^2_{adj}	0.445	0.313

Table V. Regression Analyses of General Risk of Domestic Nuclear Power and X-ray Diagnostics, General Risk

	β value	
Explanatory variable	Nuclear power	X-ray diagnostics
Attitude	0.304	0.162
Specific radiation risk (nonnuclear)	0.297	0.225
General risk sensitivity (nonnuclear, nonradiation)	0.259	0.336
R^2_{adj}	0.459	0.335

The fact that attitude plays such a prominent role in the models is interesting. It suggests that risk perception is to a large extent a question of ideology in a very specific sense, not in the general sense that is posited by Cultural Theory. People who, for some reason, are strongly in favor of nuclear power tend to see it as risk free, and vice versa. This is a specific case of the general principle that people tend to see mostly good properties of those concepts or objects that they like and mostly bad properties in those that they dislike:[19] beliefs and values are often strongly correlated and psychologically interdependent.[58] Experts in the nuclear waste field see its risks as very much smaller than the public does; they are also more positive to nuclear power, and that explains part of the difference between the two groups.[30]

8. CONCLUSION

Risk perception is hard to understand. Several factors influence it, but some of the models suggested for risk perception have failed to explain more than a rather small fraction of it. Some investigators have apparently been satisfied with statistical significance as a criterion of validity, but that is a counterproductive strategy.[59] Others have presented seemingly persuasive results, but they have been based on averages and therefore quite misleading as to the explanatory power of the models. Practices such as these have clouded the view of risk perception and contributed to a premature closure. In this paper an attempt has been made to show that much remains to be done and some ideas about how better models of risk perception can be formulated have been suggested.

The model suggested in Section VII implies a different psychological functioning in risk perception than in other models. The psychometric model is cognitive in its conception and flavor—risks are indeed *perceived* according to this tradition, which coined the very term "risk perception." Here, risk perception is a function of properties of the hazards. Even if many more properties than real risk are considered in the model, a stimulus–response kind of thinking is still behind it. Cultural Theory, on the other hand, is very different. Here, risk perception is a reflection of the social context an individual finds him- or herself in. The reason why this approach fails is probably that the social context is construed in a very abstract, farfetched manner, and that social context per se by no means is the sole determinant of risk perception, if it has any influence at all, which remains to be seen.

If attitude is a crucial factor in risk perception, and the present results suggest this, then "perception" is largely an expression of specific values (not general; see Section VI). Risk communication would, with such a stance, require a very different approach from that implied by other models. The whole literature on attitude change becomes relevant, and this is a very extensive and well-established field. Also other components enter— risk sensitivity and specific fear. These are aspects that relate in a natural way to personality and clinical psychology.

A further theme of interest is that of the *consequences* of risk perception. It is simplistic just to assume that a high level of perceived risk carries with it demands for risk mitigation. Other factors are of importance,[60,61] but space precludes a detailed discussion here.

ACKNOWLEDGMENTS

This is a study within the CEC project RISKPERCOM (Contract Fl4PCT950016), supported also by the Swedish Council for Planning and Coordination of Research (FRN), the Swedish Council for Humanistic and Social Science Research (HSFR), the Swedish Nuclear Power Inspectorate (SKI), and the Swedish Radiation Protection Institute (SSI).

REFERENCES

1. L. Sjöberg, "Risk Perception by the Public and by Experts: A Dilemma in Risk Management," *Human Ecology Review* **6**, 1–9 (1999).
2. L. Sjöberg, "Policy Implications of Risk Perception Research: A Case of the Emperor's New Clothes?" paper presented at Risk Analysis: Opening the Process, organized by Society for Risk Analysis—Europe, Paris, October 11–14, 1998.
3. L. Sjöberg, A. af Wåhlberg, and P. Kvist, "The Rise of Risk: Risk Related Bills Submitted to The Swedish Parliament in 1964–65 and 1993–95," *Journal of Risk Research* **1**, 191–195 (1998).

4. F. D. Sowby, "Radiation and Other Risks," *Health Physics* **11**, 879–887 (1965).
5. C. Starr, "Social Benefit versus Technological Risk," *Science* **165**, 1232–1238 (1969).
6. H. J. Otway and J. J. Cohen, "Revealed Preferences: Comments On The Starr Benefit-Risk Relationships," Research Memorandum, 75-5, IIASA, Laxenburg, Austria (1975).
7. S. Lichtenstein *et al.*, "Judged Frequency of Lethal Events," *Journal of Experimental Psychology: Human Learning and Memory* **4**, 551–578 (1978).
8. D. von Winterfeldt, R. S. John, and K. Borcherding, "Cognitive Components of Risk Ratings," *Risk Analysis* **1**, 277–287 (1981).
9. B. Vessby *et al.*, "Våra Dominerande Hälsorisker," Skrift **5**, Riskkollegiet (1992).
10. C. P. Thompson and D. Mingay, "Estimating the Frequency of Everyday Events," *Applied Cognitive Psychology* **5**, 497–510 (1991).
11. A. Tversky and D. Kahneman, "Judgment Under Uncertainty: Heuristics and Biases," *Science* **185**, 1124–1131 (1974).
12. L. Sjöberg, "Strength of Belief and risk," *Policy Sciences* **11**, 39–57 (1979).
13. A. Tversky and D. Kahneman, "Availability: A Heuristic for Judging Frequency and Probability," *Cognitive Psychology* **4**, 207–232 (1973).
14. B. Combs and P. Slovic, "Newspaper Coverage of Causes of Death," *Journalism Quarterly* **56**, 837–843, 849 (1979).
15. B. Fischhoff, P. Slovic, and S. Lichtenstein, "Lay Foibles and Expert Fables in Judgments about Risk," *American Statistician* **36**, 240–255 (1982).
16. W. R. Freudenburg *et al.*, "Media Coverage of Hazard Events: Analyzing the Assumptions," *Risk Analysis* **16**, 31–42 (1996).
17. A. af Wåhlberg and L. Sjöberg, "Risk Perception and the Media. A Review of Research on Media Influence on Public Risk Perception," *Journal of Risk Research* **3**, 31–50 (2000).
18. L. Sjöberg, "Beliefs and Values as Components of Attitudes," in B. Wegener (ed.), *Social Psychophysics*, pp. 199–218 (Erlbaum, Hillsdale, New Jersey, 1982).
19. L. Sjöberg and A. Biel, "Mood and Belief–Value correlation," *Acta Psychologica* **53**, 253–270 (1983).
20. H. Montgomery, "From Cognition to Action: the Search for Dominance in Decision Making," in H. Montgomery and O. Svenson (eds.), *Process and Structure in Human Decision Making*, pp. 23–50 (Wiley, Chichester, England, 1989).
21. L. Sjöberg, "Solstrålningens Risker: Attityder, Kunskaper och Riskuppfattning," RHIZIKON: Rapport från Centrum för Riskforskning, Handelshögskolan i Stockholm, 3. Centrum för Riskforskning, Handelshögskolan i Stockholm, 1994.
22. N. D. Weinstein, "Unrealistic Optimism about Illness Susceptibility: Conclusions from a Community Wide Sample," *Journal of Behavioral Medicine* **10**, 481–500 (1987).
23. L. Sjöberg, "AIDS: Riskuppfattning, Attityder och Kunskaper. En Enkätundersökning av Åldersgrupperna 30–45 år," RHIZIKON: Rapport från Centrum för Riskforskning, 1. Center for Risk Research, Stockholm School of Economics, 1991.
24. L. Sjöberg, "Perceived Risk vs Demand for Risk Reduction," RHIZIKON: Risk Research Report, 18, Center for Risk Research, Stockholm School of Economics (1994).
25. M.-L. Bernström and C. Lindholm, "In Vino Veritas. En Studie av Svenska Folkets Attityder till Systembolaget och en Friare Alkoholförsäljning," unpublished Master's thesis. Handelshögskolan i Stockholm, 1995.
26. C. Marris, I. Langford, and T. O'Riordan, "Integrating Sociological ad Psychological Approaches to Public Perceptions of Environmental Risks: Detailed Results from a Questionnaire Study," CSERGE Working Paper, GEC 96-07. Norwich, University of East Anglia, Centre for Social and Economic Research into the Global Environment, 1996.
27. B. Fischhoff *et al.*, "How Safe Is Safe Enough? A Psychometric Study of Attitudes Towards Technological Risks and Benefits," *Policy Sciences* **9**, 127–152 (1978).
28. P. M. Sandman, *Responding to Community Outrage: Strategies for Effective Risk Communication* (American Industrial Hygiene Association, Fairfax, Virginia, 1993).
29. P. Slovic, "Perception of Risk," *Science* **236**, 280–285 (1987).
30. L. Sjöberg and B.-M. Drottz-Sjöberg, "Risk Perception of Nuclear Waste: Experts and the Public," RHIZIKON: Risk Research Report, 16, Center for Risk Research, Stockholm School of Economics (1994).
31. G. T. Gardner and L. C. Gould, "Public Perceptions of the Risk and Benefits of Technology," *Risk Analysis* **9**, 225–242 (1989).
32. L. Sjöberg, "A Discussion of the Limitations of the Psychometric and Cultural Theory Approaches to Risk Perception," *Radiation Protection Dosimetry* **68**, 219–225 (1996).
33. C. Marris *et al.*, "Exploring the 'Psychometric Paradigm'": Comparisons between Aggregate and Individual Analyses," *Risk Analysis* **17**, 303–312 (1997).
34. L. Sjöberg, "Risk Perceptions by Politicians and the Public," RHIZIKON: Risk Research Reports, 23, Center for Risk Research, Stockholm School of Economics (1996).
35. L. Sjöberg and E. Winroth, "Risk, Moral Value of Actions, and Mood," *Scandinavian Journal of Psychology* **27**, 191–208 (1986).
36. L. Sjöberg and G. Torell, "The Development of Risk Acceptance and Moral Valuation," *Scandinavian Journal of Psychology* **34**, 223–236 (1993).
37. L. Sjöberg and B.-M. Drottz-Sjöberg, "Moral Value, Risk and Risk Tolerance," RHIZIKON: Risk Research Report, 11, Center for Risk Research, Stockholm School of Economics (1993).
38. M. Douglas and A. Wildavsky, *Risk and Culture* (University of California Press, Berkeley, 1982).
39. K. Dake, "Technology on Trial: Orienting Dispositions toward Environmental and Health Hazards," Ph. D. thesis, University of California, Berkeley (1990).
40. K. Dake, "Orienting Dispositions in the Perception Of Risk," *Journal of Cross-Cultural Psychology* **22**, 61–82 (1991).
41. Å. Boholm, "The Cultural Theory of Risk: An Anthropological Critique," *Ethnos* **61**, 64–84 (1996).
42. L. Sjöberg, "Explaining Risk Perception: An Empirical and Quantitative Evaluation of Cultural Theory," *Risk Decision and Policy* **2**, 113–130 (1997).
43. S. Rayner, "Cultural Theory and Risk Analysis," in S. Krimsky, and D. Golding (eds.), *Social Theories of Risk*, pp. 83–116 (Praeger, Westport, CT, 1992)
44. A. Wildavsky and K. Dake, "Theories of Risk Perception: Who Fears What and Why?" *Daedalus* **119**(4), 41–60 (1990).
45. L. Sjöberg, "World Views, Political Attitudes and Risk Perception," *Risk—Health, Safety and Environment* **9**, 137–152 (1998).
46. J. Brenot and S. Bonnefous, "Approche Socio-culturelle de la Perception des Risques," Note SEGR/LSEES, 95–17, Fontenay-aux-Roses: IPSN, 1995.
47. L. Sjöberg, "Risk Perception by Experts And the Public," Rhizikon: Risk Research Report, 4, Center for Risk Research, Stockholm School of Economics (1991).
48. L. Sjöberg, "Life-Styles and Risk Perception," RHIZIKON: Risk Research Report, 14, Center for Risk Research, Stockholm School of Economics (1993).
49. L. R. Kahle, S. E. Beatty, and P. Homer, "Alternative Measurement Approaches to Consumer Values: The List of Values (LOV) and Values and Life Style (VALS)," *Journal of Consumer Research* **13**, 405–409 (1986).
50. L. R. Kahle, "The Nine Nations of North America and the Value Basis of Geographic Segmentation," *Journal of Marketing* **50** (2, April) (1986).
51. R. E. Dunlap *et al.*, "Measuring Endorsement of an Ecological Worldview: A Revised NEP Scale," paper presented at annual

meeting, organized by Rural Sociological Society, State College, Pennsylvania, August (1992).
52. R. Inglehart, *Culture Shift in Advanced Industrial Society* (Princeton University Press, Princeton, NJ, 1990).
53. S. H. Schwartz, "Universals in the Content and Structure of Values: Theoretical Advances and Empirical Tests in 20 Countries," *Advances in Experimental Social Psychology* **25**, 1–65 (1992).
54. W. Kempton, J. S. Boster, and J. A. Hartley, *Environmental Values in American Vulture* (MIT Press, Cambridge, 1995) .
55. L. Sjöberg, "Explaining Risk Perception: An Empirical and Quantitative Evaluation of Cultural Theory," Rhizikon: Risk Research Reports, 22, Center for Risk Research, Stockholm School of Economics (1995).
56. M. Fishbein and I. Ajzen, *Belief, Attitude, Intention, and Behavior: An Introduction to Theory and Research* (Addison-Wesley, Reading, Massachusetts, 1975).
57. L. Sjöberg, "Psychological Reactions to a Nuclear Accident," Paper presented at the Proceedings of a Conference on The Radiological and Radiation Protection Problems in Nordic Regions, Tromsö 21–22 November, 1991, Paper 12, J. Baarli (ed.) (Nordic Society for Radiation Protection, Oslo, 1992).
58. L. Sjöberg and H. Montgomery, "Double Denial in Attitude Formation," *Journal of Applied Social Psychology* **29**, 606–621 (1999).
59. F. L. Schmidt," Statistical Significance Testing and Cumulative Knowledge in Psychology: Implications for Training of Researchers," *Psychological Methods* **1**, 115–129 (1996).
60. L. Sjöberg, "Why Do People Demand Risk Reduction?" paper presented at the ESREL-98: Safety and Reliability, S. Lydersen, G. K. Hansen, and H. A. Sandtorv (eds.), pp. 751–758 (Trondheim: A. A. Balkema, 1998).
61. L. Sjöberg, "Perceived Risk vs Demand For Risk Reduction," *Journal of Risk Research* **2** (in press).