INTUITIVE RISK PERCEPTION: RESEARCH RESULTS OF ATTITUDE SURVEYS TOWARD RISK AND TECHNOLOGY

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ABSTRACT

Using the instruments of the empirical social sciences, a cross-section study was conducted comprising experiments on qualitative risk characteristics, in-depth interviews on mechanisms of risk perception and representative surveys of the public on technical risk sources, in particular with regard to nuclear energy. The results of these studies show that person-related expectations in respect of risk consequences, the possibility of personal influencing control, the severity of risk consequences and one's own risk propensity play a significant role in the evaluation of risks.

INTRODUCTION

Risk investigation is experiencing a boom at the moment. On the one hand more and more refined procedures are being developed to estimate the objectively given risks to health and life from technologies and activities, on the other hand cognitive psychology is trying to pick up the trail of the process of intuitive risk perception. Previous investigations about risk perception by the population have been principally based on three methodological concepts:

- the descriptive decision theory model (utility theories),
- the model of risk-specific perception factors, such as voluntariness or possibility of control, and
- the attitude model.

The main emphasis of previous investigations has been in the area of risk-specific perception factors, which were either more or less indirectly reconstructed by means of "Revealed Preference Analysis" from the history of risk source acceptance (Starr, 77) or their significance was measured by direct surveys (Fischhoff et al., 78). Work on the attitude concept is more closely related to the cognitive structure of risk perception and is largely being pursued by the IAEA Risk Assessment Group in Vienna (Otway, 77). Finally, studies in decision theory are at the moment being carried out at the University of Southern California (von Winterfeldt et al., 81), about the value beliefs of relevant groups in the nuclear controversy. In this connection the perception of risk aspects is understood as a process of attributing predetermined value commitments to concrete risk objects.

In addition there is a series of studies, whose research conception has a shifting perspective. Among these we should particularly mention the studies of the Battelle Institute (Melber, 77), which have principally taken attitude models and conflict models as the starting point for their investigations. Scientific sociological studies are equally worth mentioning, especially those by H. Nowotny (76), D. Nelkin (76) and J.R. Ravetz (79), which deal with the reactions of the scientific system and the public to the controversy between real or apparent experts.

The diversity of starting points and methods attempting to research risk perception scientifically has led to a confusion of concepts and to a muddled multiplicity of competing theories and explanations. In order to be able to classify our research results better it seems imperative to us to begin by defining the most important concepts.

THEORETICAL BASES OF RISK PERCEPTION

In our empirical research we took the following definitions as our starting point:

- Risk is understood as the sum total of possible consequences of a technology or an activity, which are classified as negative by affected and/or non-affected persons.
- Risk perception describes the process of mentally representing and internally assimilating the consequences of a technology or activity considered possible by individuals and groups.
- Attitude towards risk reflects the result of balancing perceived positive and negative consequences of a technology or activity. Cognitive beliefs about consequences are weighted according to the possibility of their occurrence and according to their affective evaluation and merge together into an overall evaluation relevant to action.

We do not need to deal with the concept of risk acceptance here because it implicitly entails the presupposition that risk-related features govern the acceptance of technologies and activities. However, according to our investigations the realization seems to emerge that the risk source's associations

influence acceptance, i.e. assent to the implementation of a technology or the performance of an activity, to a greater extent than risk perception factors. The division into features relating to the risk and those relating to the risk source is admittedly purely an analytical expedient for psychological research. In reality people only judge risk sources and not risks (cf. also Brown, Green, 80). Skiing and nuclear energy, marriage and driving - all of them activities connected with risks - have practically no points of contact in the population's intuitive perception. The risk expert, who by means of his scientific evaluation procedures can make a meaningful comparison between risks from different risk sources - for example how many accidents with fatal consequences are to be expected on the basis of some activity or another - , frequently transfers this analytical way of thinking to general risk perception and is then surprised if his elaborate risk comparisons, for instance between skiing and nuclear energy, meet with a complete lack of understanding in the population at large. This is not, as is often asserted in the literature, because laymen and experts define risks in different ways, but rather because of the abstractness of the scientific risk concept and its concomitant character of a universal criterion. These are both characteristics which run counter to the intuitive perception of the physical environment from every day experience. We can only incidentally note that there are of course also limits to the level of abstraction of scientific risk evaluation. The question of whether it is more dangerous to get married or to live next-door to a nuclear power station surely no longer has any meaning even for the most inveterate devotee of risk comparisons, although the question, from a purely statistical point of view, can be answered.

Would it then not be better to expel the concept of risk perception from the terminology of cognitive psychology and replace it by object perception? This sort of recommendation can indeed be justified in view of the often unthinking use of the concept of risk perception, but is not necessary from the nature of the case. For perception of an object naturally also includes perception of the hazardous consequences of this object and their mental assimilation. Thus, the hierarchical rank of aspects related to risk or benefit with respect to object assessment can be analytically investigated. In the same way the separate measurement of object and risk perception can answer the question whether there are typical patterns in the intuitive perception of risk sources which can give us some pointers towards the "Common Sense" assimilation of uncertainty through potential danger sources. Therefore in the following those factors will be discussed in more detail which influence the process of risk perception and the formation of a risk attitude. However - and this must be emphasized once again - this does not mean attitude to the object. We have admittedly, on the basis of the work of the IAEA Risk Assessment Group (Otway 77; Thomas 79), subsumed belief factors about the individual risk sources under the risk-specific method, so that attitudes to the object are also roughly covered.

If one attempts to summarize the significant factors in risk perception on the grounds of empirical studies carried out up to now, then five levels of influence can be mentioned:

- perceived expected values (estimates of average loss rates per unit time)
- perceived catastrophe potential (estimates of the maximum conceivable accident)

- qualitative risk features (circumstances accompanying the risk situation, such as voluntariness or possibility of control)
- associations and expectations with respect to the consequences of the risk source (so-called belief system)
- features relating to personality such as risk propensity or benefit orientation, and social factors such as class or value orientation.

These five levels will be briefly discussed in the following chapters.

EXPECTED VALUES AND CATASTROPHE POTENTIALS

In actuarial and scientific risk theory the expected values of breakdowns or consequences of damage for an installation or a project are synonymous with the term risk. Risk sources are roughly judged according to how many losses per unit time are to be expected on the basis of experience or hypothetical calculations. In this respect the question arises whether

- the population is aware of the statistically computed expected values and uses them as a basis for their risk estimation, or whether
- the population is indeed aware of the statistically computed results but does not use them as a basis for their risk estimation, or whether finally
- the population is not aware of the statistical values and estimates the "expected values" as they see fit and carries out their risk assessment accordingly.

The question which of the three hypotheses is appropriate can be answered with the aid of the two Figures 1 and 2. An American (Slovic, 79 p. 3) and a German survey (Renn, 81a Vol. II, p. 41) were given the task of estimating the average losses per year from different risk sources. The estimated values determined in this way are represented in the two graphs by the ordinates, the real statistical figures are plotted on the abscissa.

It can be clearly seen from the two Figures that the intuitive loss expectancy and the statistical expected values are relatively close together. The American interviewees underestimated risks with very high loss rates and overestimated risks with very low loss rates, i.e. the variation in values for intuitive risk estimation is significantly less pronounced and is more closely approximated to the general mean. A similar trend can be determined in the German investigation; however, a slight overestimation of all loss expectancies without exception can be observed here. In this connection it is interesting to note that the logarithmized values of the real loss rate correlate with the perceived rate with a factor of 0.87 ($p < 0.001$).

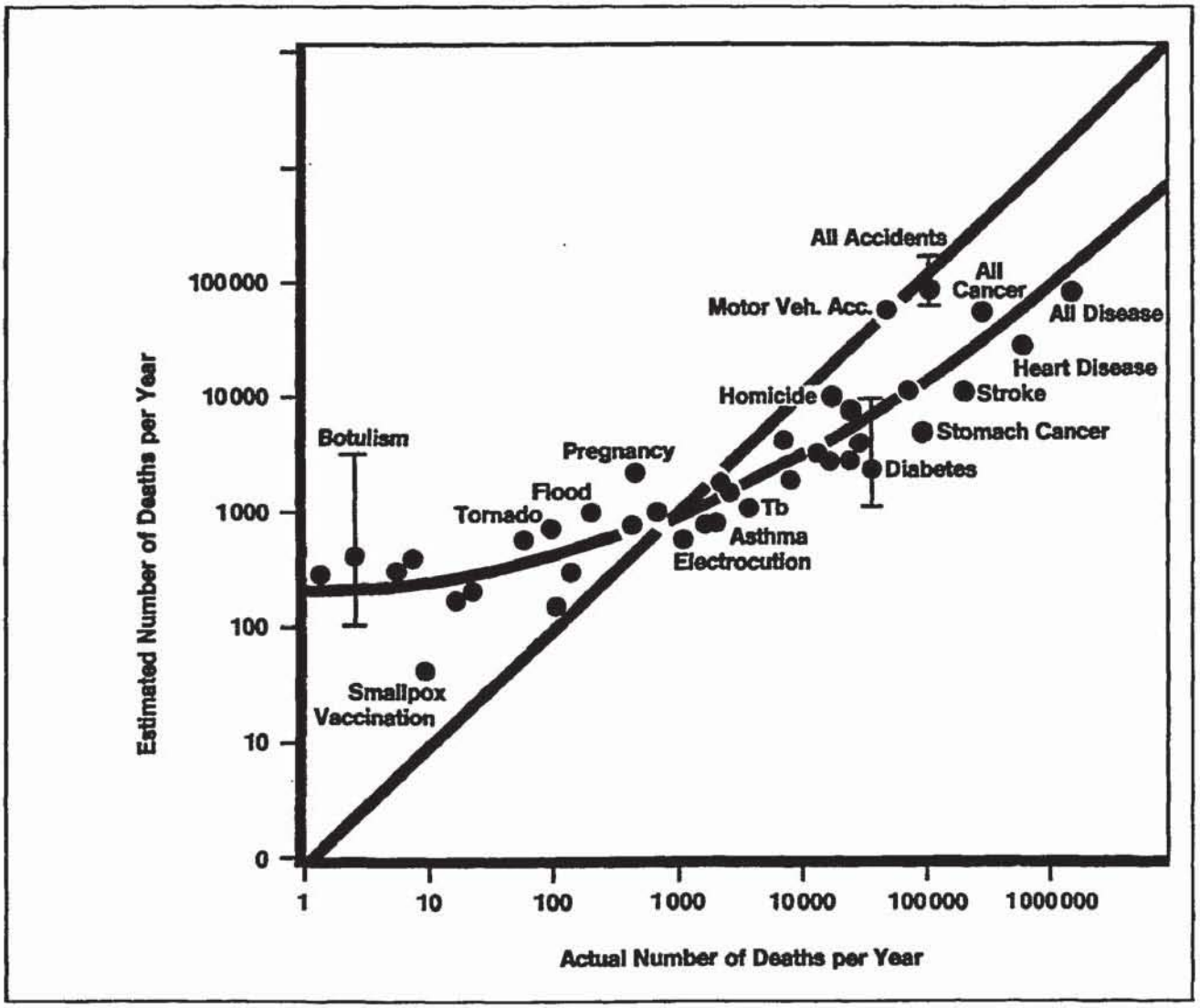

Fig. 1 The Discrepancy between Estimated and Statistically Calculated Loss Rates (American Survey).

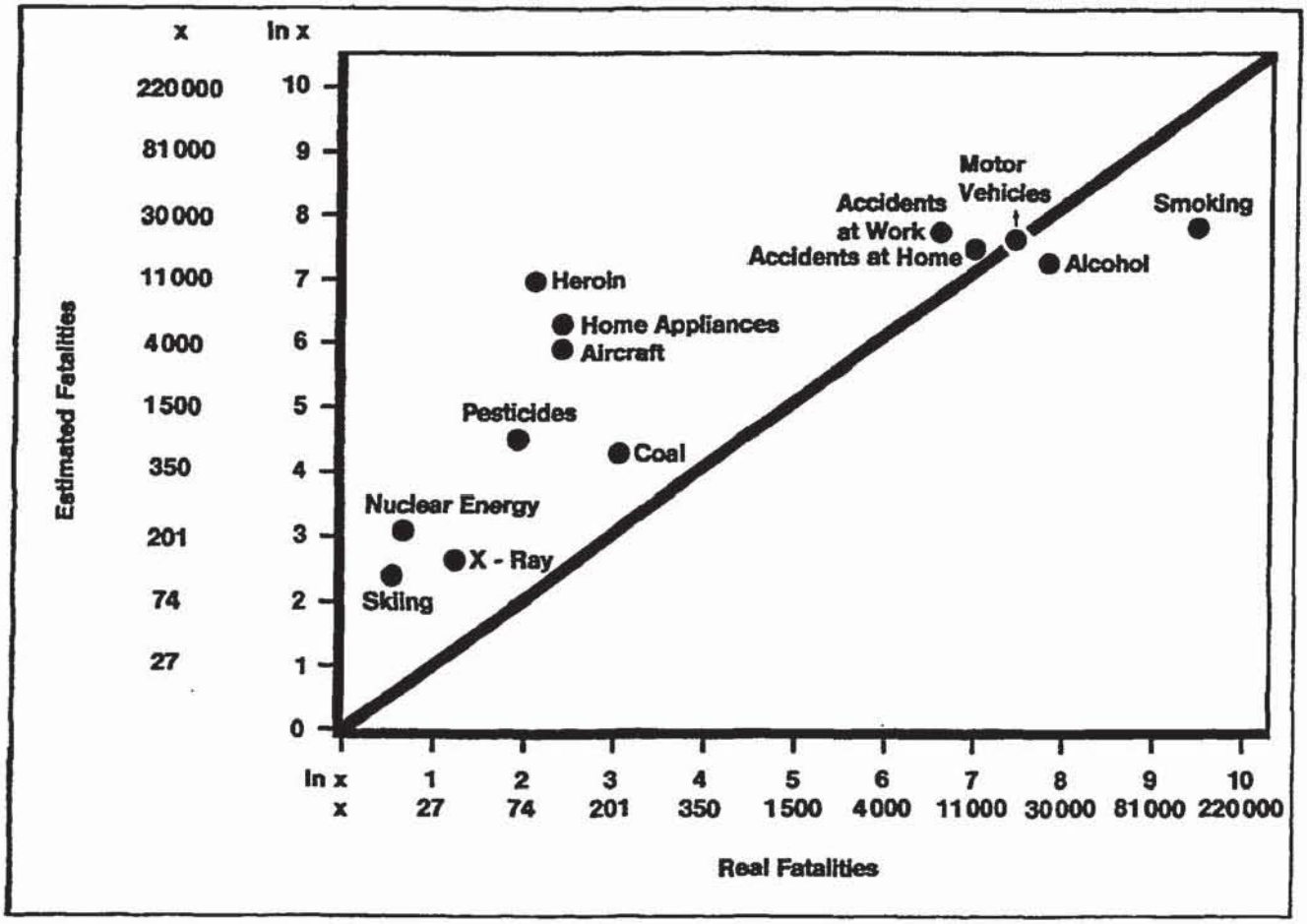

Fig. 2 The Discrepancy between Estimated and Statistically Calculated Loss Rates (German Survey).

If one relates the real or intuitive estimated values for losses to the values of an evaluation scale for the risk level, the benefit level and a risk--benefit index (in each case filled in by the same interviewee), then one obtains an astonishing result. Presumed loss rates per year and intuitive risk perception are practically independent of each other, i.e. most people do not assess risk sources according to the presumed losses per year, but they rather orientate themselves towards other points of view (Renn, 80a). This insight is not only true of the German interviewees; American, English, French and Australian investigations confirm the low relation between loss estimation and risk perception (Fischhoff et al., 78; Poschin, 75; Dumenil, 77; Glennon, 81). In the same way we were able to prove by empirical polls that statistical calculations about risk perception are classified as completely credible and appropriate; only in the case of nuclear energy were there occasional doubts. We feel justified in drawing the following conclusion from these results: most people are more or less aware of the expected values of well-known risks, however, the expected values are merely one factor among many in the assessment of these

risks and, as correlation analyses show, a factor with only slight explanatory value.

Since the expected values of risks are defined as the sum of the severity multiplied by the probability of their occurrence, different weightings of the two factors could, of course be present in the intuitive perception of risks and the difference between statistical and intuitive evaluation be based not on the use of expected values, but rather on their structure. In decision analysis therefore an exponent is added to the risk equation which takes into consideration the subjective utility attribute (or risk evaluation) of different orders of magnitude (cf. Brown/Green, 80). In particular the hypothesis has been put forward that the hazard potential in the case of risk, that is to say the extent of the maximum conceivable accident, has a significant influence on weighting. Whereas Slovic et al. were only able to prove this type of influence in the case of nuclear energy (81, p. 10), von Winterfeldt and Otway report a division of risk sources into individual activities, which are assessed with more respect to the average expected value, and technological sources, which are principally evaluated according to the most severe accident considered possible (von Winterfeldt, Otway, 80). Green and Brown are of the opinion that the intuitive expected value comes into being on the basis of an internal weighting of average losses, catastrophe potentials and the perceived long-term threat to health and that this weighted expected value also best describes risk evaluation (Green/Brown, 81). In contrast our own investigations suggest a different conclusion: most people are quite simply overtaxed if asked to evaluate catastrophe potentials. Risk sources are either grossly overestimated or all of them are perceived as being of the same order of magnitude. There is therefore reason for considerable doubt about whether perceived catastrophe potentials really exercise a dominant influence on risk perception. This scepticism does not debar the value of new risk definitions in order to attain a weighting of severity and probability paying sufficient attention to perception.

QUALITATIVE RISK FEATURES

The attendant circumstances, the way in which people are exposed to a certain risk, are considered in the literature to be an essential explanatory variable for the intuitive evaluation of risks. What do we mean by this?

A small experiment which we carried out with 36 test subjects can explain the way in which these qualitative features operate. Two groups of test subjects chosen at random were asked by the organizer of the test to take part in a trial of pharmaceutical products. It was supposed to be concerned with testing three different capsule coatings with respect to possible unpleasant side effects. According to the organizer of the test, the coating of the first capsule contained radioactive material, the second bacterial material and the third heavy metal, with the effect that all three dissolved in the stomach more quickly than conventional capsules. None of the three capsules presented any risk to health. In reality the three capsules were three absolutely identical commercially available vitamin preparations. The first group were able to make a free choice from the three possibilities; each member of the second group was allocated a capsule by the organizer of the experiment. After taking the capsule the test

subjects had to fill in a questionnaire where they were asked to give information about possible ill effects (stomach pains, nausea etc.). The result of this experiment is depicted in Fig. 3. Although all the test subjects had swallowed an identical capsule, the members of group 1, who had not been allowed to choose, said that they felt unwell on the average twice as often as those who had been able to choose a capsule. This result was completely independent of which capsule coating they chose or were forced to take. An interesting marginal note is the fact that the allegedly radioactive capsule most frequently caused ill effects in both groups.

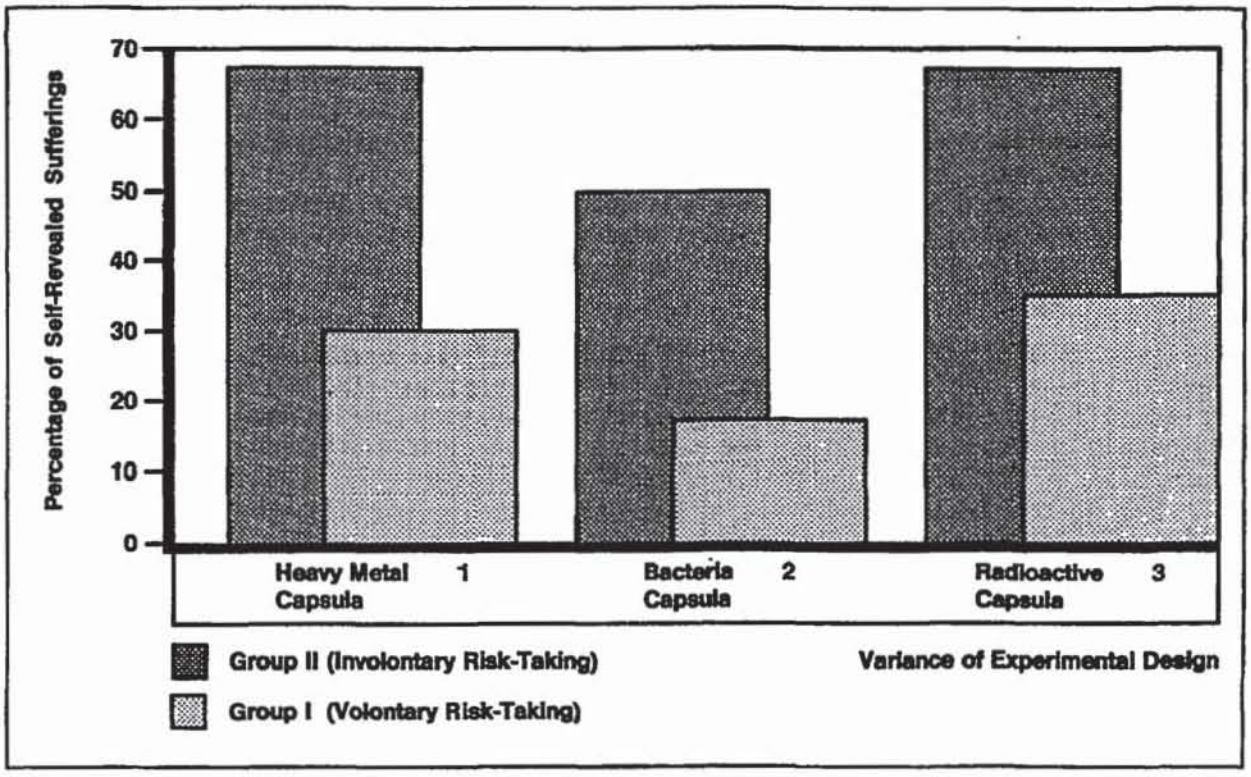

Fig. 3 Result of the Capsule Experiment: Risks Undertaken Voluntarily were Clearly Connected with Fewer Imaginary Ill Effects.

That voluntariness represents a significant parameter in risk perception has long been an important component of psychological risk and decision theory. The American risk expert C. Starr has underlined the significance of these variables in quite a different way. A comparison of statistical loss rates caused by various risk sources provided the result that socially accepted risks, which are entered into voluntarily, show a thousand times higher loss rate than risks which can be regarded as forcibly imposed.

Voluntariness is only one of many risk features which in the meantime have been recognized as influence variables in risk evaluation. According to investigations by the Institute of Perceptronics in Oregon the following have turned out to be particularly relevant; the common dread of an accident, its severity and - to a somewhat more limited extent - the voluntariness of the risk circumstances (Fischhoff et al., 78). The multiple correlation coefficient for risk evaluation together with the expected values for losses in normal and catastrophic years amounted to 0.95, and in this way risk evaluation can be predicted with a probability of 90 % (Slovic et al., 80). We also tested the significance of the qualitative variables analogously to the American investigations. In addition to risk-related features we also included benefit-related attributes, as for example "profit personally from it" or "it benefits everybody to the same extent". In order to estimate the joint influence of these qualitative features on risk classification, multiple correlation procedures (regression techniques) were also applied, by means of which the joint influence of the independent variables on the phenomenon to be explained (in this case intuitive risk evaluation) can be measured.

Fig. 4 shows the significance of the individual qualitative features for the evaluation of the risk in question for 9 risk sources. The corresponding correlation coefficient is on the y-axis, that is to say the intensity of the relationship is depicted, and on the x-axis are the boxes with the individual feature classes for nine different risk sources.

If one first considers the primary factors, that is to say the features which exert the greatest influence on risk evaluation, then it becomes apparent that benefit-related points of view predominate. People first of all evaluate risks according to the possibilities and accompanying circumstances of their application, for example whether they themselves can profit from them, whether they are of benefit to everyone or only a minority, whether there are not further alternatives, which provide the same benefit with less risk. In the case of nuclear energy, pesticides and electrical appliances the emphasis is on risk features. Whereas the voluntariness of utilization brings about a positive weighting of the concomitant risk in the case of electrical appliances, the dominance of the factor "catastrophic consequences possible" in the case of nuclear energy and "possibilities of long-term damage" in the case of pesticides has a negative effect on risk perception. It is thus clear that statistical loss rates are not the decisive motives for scepticism towards nuclear energy and pesticides. A dominant role for qualitative features in intuitive risk evaluation cannot be seen from the height of the correlation coefficients, although their influence is quite clear. The fraction of declared variance for the independent variable risk evaluation is under 25 % in the case of almost all risk sources.

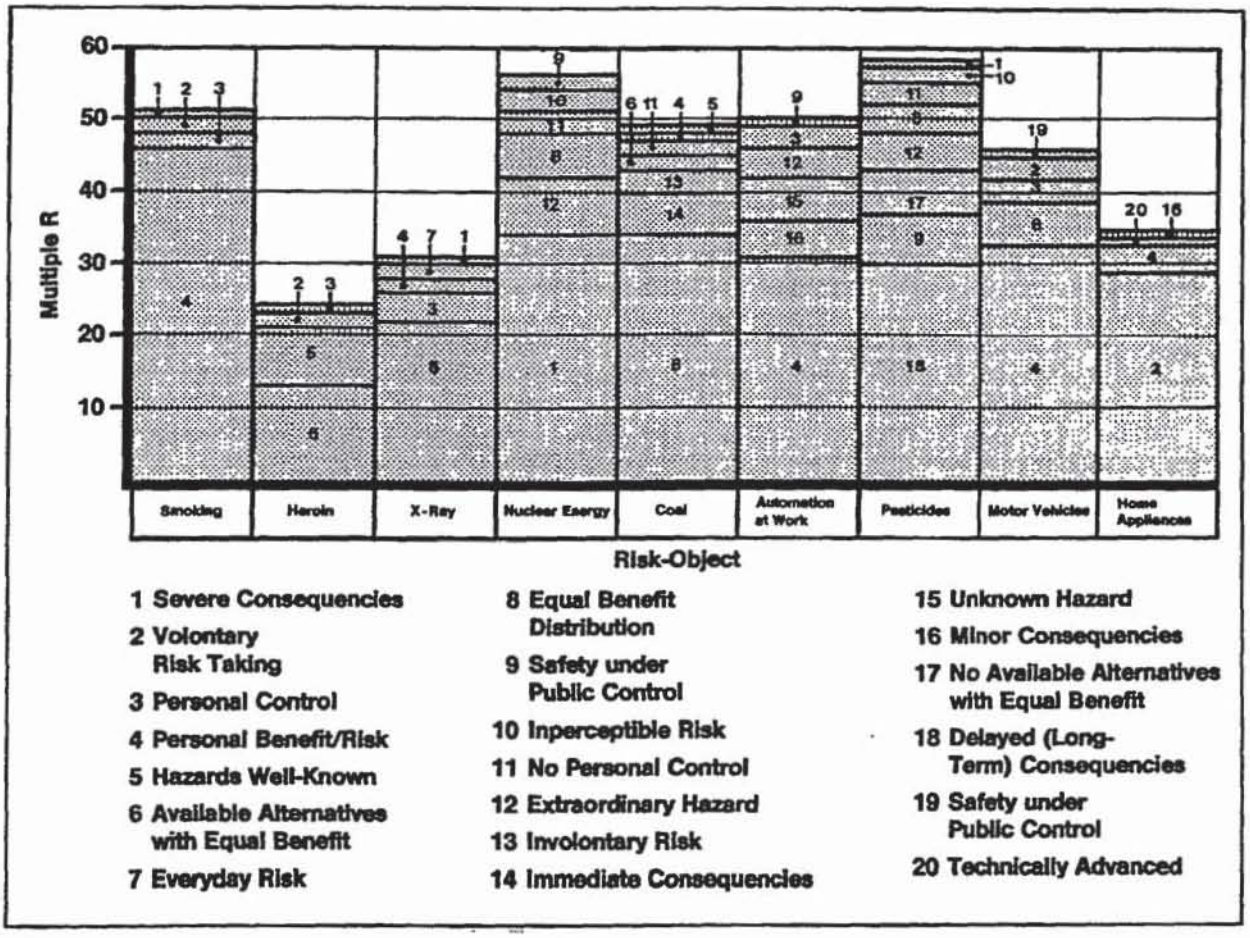

Fig. 4 The Influence of Qualitative Risk and Benefit Features on the General Perception of Risk and Benefit from Various Risk Sources (Multiple Correlation Coefficient)

This result contradicts the American investigations, according to which between 70 and 90 % of the variance in risk evaluation could be explained by qualitative risk features. This discrepancy can be traced back to genuine differences between the German and American interviewees, however the aggregation method used by Slovic and others could also be the reason since higher correlation coefficients are caused by this procedure. We therefore feel justified in concluding that qualitative features do indeed represent an important factor in risk evaluation, but they are by no means as decisive as suggested by many psychological studies of risk perception.

BELIEFS ABOUT RISK SOURCE

Whereas expected loss rates, catastrophe potentials and qualitative risk or benefit features are more or less universal criteria for all possible risk sources, the level of variables in the belief system describes people's cognitive expectations about the risk object or risk activity. As we have already indicated in the Introduction, people do not separate risk from the risk object. The risk is only plastically estimated if the individual can see a connection with his ideas and opinions about the risk object.

It is very problematical for empirical research to measure the beliefs people have about each risk source and to discover typical perception patterns. Extensive experiments by the "Risk Assessment Group" of the International Atomic Energy Agency (IAEA) in Vienna come to the result that people evaluate their beliefs according to the following criteria (Thomas et al., 79):

- Indirect Risk (Future-Oriented and Political)
- Economic Benefit (Increasing Standard of Living)
- Environmental Risk (Air Pollution)
- Psychological and Physical Risk (Personal Control of Risk)
- Technological Development (e.g. Technical Spin-Offs)

The difficulty with the IAEA investigations is to be found in the standardization of the set of factors for all risk sources. This artificial universalization was partly achieved by transferring the sets of factors for nuclear energy to the other energy sources and partly with the aid of a three-dimensional factor analysis. The actually most important result of the analysis is in both cases concealed; even in the case of such closely related risk sources as nuclear energy, coal, oil, solar energy and hydro power there are always different factor compositions in spite of absolutely identical belief scales. This particularly emphasizes the fact that evaluation is specific to the risk source and is not based on an intuitive universal weighting standard.

Therefore in addition to the aggregation procedure used by the IAEA, in our investigations we also carried out several factor analyses for each risk source and interpreted some typical perception patterns from the structure of the various factor compositions. We were able to detect the following connections, which - in spite of all due caution with such (fairly arbitrary) interpretation schemes, - can be regarded as relatively certain insights:

- Risk sources with extremely positive risk-benefit evaluation are characterized by a common feature, namely that values and advantages related to the subject play a dominant role (e.g. electrical appliances, X-ray diagnostics, cars).
- Risk sources with a relatively positive evaluation (intermediate position) are distinguished by a heavy emphasis upon socio-economic advantages, which only affect one's own person to a slight extent (aircraft, automation).

- Risk sources which are more ambivalently evaluated (nuclear energy, pesticides) are primarily connected with socio-political and social disadvantages, whereas health aspects and perceived economic advantages are roughly balanced.
- Risk sources with a clearly negative evaluation (e.g. alcohol, nicotine, heroin) are in the first place associated with damage to one's own health.

It therefore seems that precisely subject-related expectations are decisive in risk perception for extreme evaluations, whereas risk sources in the medium range of the perception scale are more closely connected with socio-economic expectations, in which case they are either positively or negatively received, according to the prognostication.

It must be clearly emphasized that in the results described here the intuitive evaluation of a risk through a risk source was chosen as the dependent variable and not the acceptance of this risk. Thus for example stimulants, such as alcohol, are classified as very hazardous, but thoroughly acceptable because they can be individualized. The acceptance of a risk depends much more on the degree of voluntariness with which it is undertaken than the classification of the risk by the degree of perceived hazardousness.

If one enquires once again about the degree of declared variance for risk evaluation, then belief factors prove to be the primary explanatory variables. About 30 - 70 % of the variance in risk evaluation or in risk-benefit estimation could be explained by the concerted effect of the belief system. Moreover it became apparent that by means of a multiple correlation analysis, including at the same time qualitative features and the belief system, that qualitative factors only improve the explanatory value of belief factors to a slight extent. The qualitative features could only be proved to have a greater influence if the interviewees had preferred extreme values (positive and negative) and a bimodal distribution of values had therefore resulted. We can therefore conclude from this that expectations about the risk source primarily determine perception, nevertheless in perceiving extremes within the qualitative features the evaluation of this risk-specific situation can almost be regarded as a universal weighting factor in the intuitive "risk formula".

PERSONALITY AND SOCIAL FEATURES

As the last influence value we must mention certain individual characteristics and features which can exert an influence on risk perception. This is not concerned with the social or psychological patterns of the attitude field, but rather with people's risk-related thought and deduction processes. Utility theory has always differentiated between people who are averse to risks, indifferent to risks and responsive to risk. Proof of the influence of personal orientation on one's own behaviour has been repeatedly furnished for "gambling situations", which are particularly typical of this discipline.

The question about the role of personality features is rather underrepresented in the general theory of risk perception. Earlier studies (for example those of Kogan/Wallach, 72) suggest this sort of influence, whereas more recent studies presuppose an invariance in personality-related features, although they do assume a relationship among features relating to the group (such as a general value consciousness) (Kozielecki, 74).

We therefore attempted to investigate the two variables with respect to their significance for risk perception. Risk propensity and the emphasis on beneficial or detrimental aspects of a risk source were chosen as the most important features for personality-related features and were indirectly deduced from the interviewees' responses. In addition to the usual demographic and social features, social value orientations were included on several scales, which reflected general socio-political attitudes, such as conservatism or environmental consciousness. Both classes of variables proved in part to be relevant factors in risk perception.

It became apparent in the question of personal risk propensity that a positive risk-benefit estimation of technical and industrial sources requires positive risk propensity, but that this is not necessary for stimulants. Stimulants, which can be individualized, are only classified as less acceptable if there is a consciously negative relationship to risk; on the other hand technical or industrial risks already encounter acceptance difficulties if there is no positive attitude to risk acceptance. In contrast most features relating to the social group or demographical data exert hardly any influence on the perception of risks, regardless of which risk source is chosen. Only sex and class were of significance in some risk sources, e.g. nuclear energy, pesticides and air travel. General socio-political attitudes enabled one to recognize a connection with risk perception if conflicts about the risk source had already led to polarized and politicized points of view in society. An example of this is given in Fig. 5 where the relationships between risk-benefit estimates for nuclear energy and five attitude fields are shown.

This graphical representation clearly gives the impression that above all confidence in the achievements of science and technology ($r = 0.49$) as well as environmental consciousness ($r = 0.35$) exercises a highly significant influence ($P < 0.001$) on the perceived risk-benefit balance. A conservative way of life and little interest in active participation in politics tends to lead to positive risk-benefit values. If one considers the political conflict about nuclear energy and its function as a substitute for an exemplary conflict of values between materialistic and post-materialistic orientations, (Renn, 80a, Vol. III), then this result is not very surprising. What is interesting about this relatively high correlation is, however, the fact that attitude to nuclear energy was not taken as the dependent variable, but rather its perceived risk-benefit balance. There is little change in this result if only the extent of the risk or benefit is included in the analysis instead of the balanced risk-benefit ratio. Once again this shows the close intertwinement between risk perception and risk source perception.

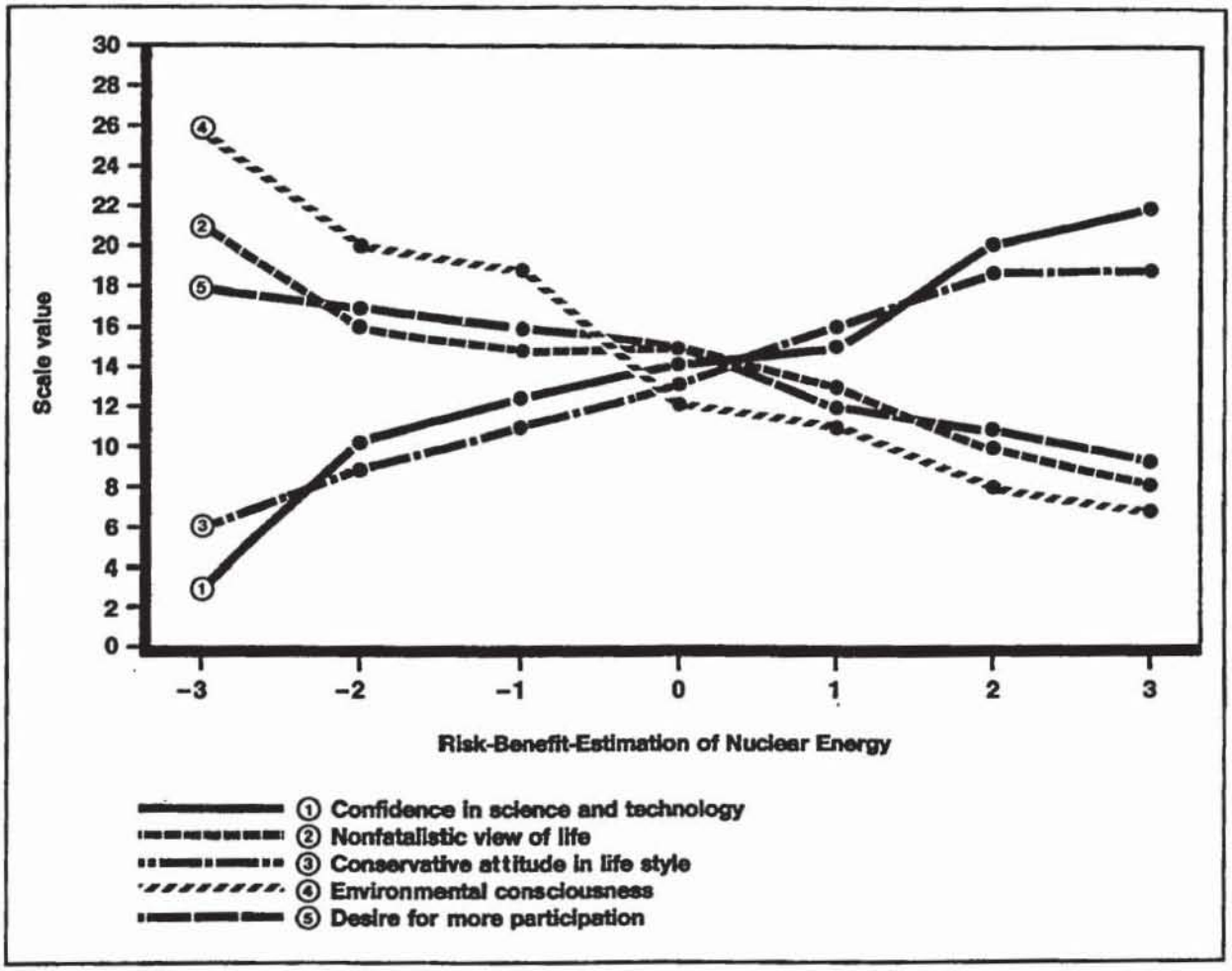

Fig. 5 The Influence of Five Different Socio-Political Attitudes on the Perception of the Risk and Benefit of Nuclear Energy

CONCLUSION

The results of the perception investigations give a clear indication of the way in which people intuitively perceive risk sources. Most people have generally reliable beliefs about the average loss rates from various risks, which however - unlike scientists and actuaries - they do not regard as a criterion for risk assessment. On the one hand the accompanying circumstances of the hazardous situations and on the other the expected consequences for general social, economic and future-orientated interests are of central significance for them. In addition personal attitudes towards hazardous circumstances and general value beliefs according to the degree of political polarization - which vary from individual to individual - play a role which must not be underestimated.

These results are not only of academic relevance. The artificially constructed opposition between rational expert evaluation and allegedly irrational lay estimation has not only disguised the real situation in the present discussion about risks, but has also simultaneously considerably obstructed a dialogue between the two positions. The technical calculation of the extent of a particular risk can undoubtedly be regarded as an important component in decisions about risk sources and at the same time an ideal tool with which to continually improve the population's safety. However, the population does not dispute this at all! Nevertheless it would contradict an intuitive understanding of risk acceptance, nor would it be sensible from a socio-political point of view, to make calculations of this sort the sole criterion of the "acceptability" or "desirability" of technologies or other civilizatory risk sources.

It is therefore the task of the political decision makers to recognize the patterns of risk perception, to critically discuss the content of these patterns, to correct any possible undesirable trends or to avert them in advance and finally to make reconstructible decisions which comprise all levels of intuitive perception. Even if the conflict potential of controversial topics, such as the introduction of nuclear energy, cannot be dismantled, then investigations about perception can at least provide an opportunity for the impression that experts, the general public and politicians continually talk at cross-purposes to be overcome and replaced by a genuine dialogue.

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