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Man, Technology and Risk

A Study on Intuitive Risk Assessment and Attitudes towards Nuclear Energy

by

O. Renn

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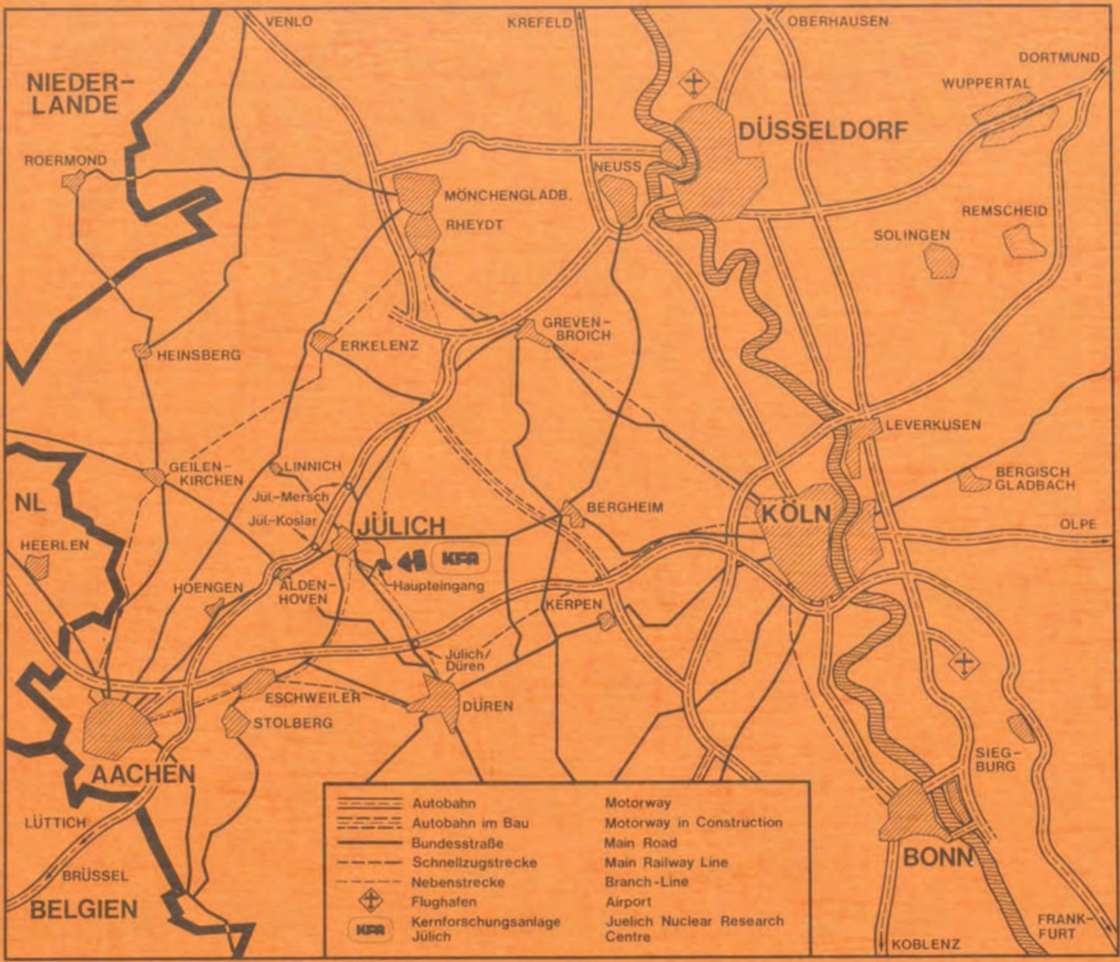

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Abstract

Using the instruments of 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 severeness of risk consequences and one's own risk propensity play a significant role in the evaluation of risks.

Introduction

Risk - a multifarious concept: A gambler hoping to win, an actuary computing life expectations, an industrialist estimating his marketing opportunities, a family evaluating the future usefulness of a consumer product, a patient visualizing the success or failure of surgery, a technician investigating the probabilities of skiing accidents or malfunctions - all of them start out from a common concept: risk. But do they always mean the same thing?

What is risk? The scientist has a clear-cut and fast answer to this question: Risk is the sum total of all probabilities, p, multiplied by the valuations of possible consequences,c. It is on the basis of this formula that risk analyses are computed for technological systems, nuclear power stations, road traffic, dams and bridges, but also for the side effects of pharmaceuticals, for environmental pollution or for noxious substances.

But can we use such a formula when it involves personal risk considerations when buying consumer goods, problems of the individual or collective acceptance of technological risk sources, usefulness or absurdity of leisure occupation, or the psyche of compulsive gamblers? Certainly not! But to this date psychology, the science responsible for this field, has rather neglected the topic of risk. Many works on decision-making theory, as stated by the social psychologists Janis and Mann, do not even mention the risk concept. This has probably been due to the fact that this word is used to define so many different ideas that its definition has become vague.

The present study represents an attempt to bridge this gap in psychological research and to furnish a contribution toward a psychology of risk. Such an undertaking of course requires the selection of an exemplary risk source, unless the investigator accepts being bogged down in a multitude of examples and their peculiarities. Nuclear energy was selected as this exemplary risk source. Why? There is hardly any technological facility which has ever stirred the consciences of the Western World as nuclear power stations and their associated plants. Hardly any facility has become so associated with risk, and hardly any technology has so shaped the perception of our industrial culture. The selection of this example is less a tribute to the topicality of this conflict than a calculus in the researcher's terms of reference, using the past discussion on the nuclear energy risk and its rational and emotional assimilation by the populace as a data base for an empirical study. For in this example, attitudes already exist, and object perception structures are well developed.

These advantages of object selection can be gained only by accepting an important disadvantage. In a phase of political confrontation between opponents and supporters, studies in the social sciences often have only a rationalizing character. They are used either to substantiate one's own judgement of this issue via a social science analysis, or to provide one's reference group with data and arguments for better armament in its conflict with the opponent. Neither was our intention. In order to avoid the danger of allowing our own attitudes to become part of the interpretation, this study includes only analyses on perception processes and attitude structures of the survey respondents, without any attempt at evaluation or criticism of the responses. Of course, this approach does not preclude that concepts such as risk, risk estimation and risk perception are subjected to conceptual clarification.

In spite of the exemplary approach the discussion is not confined to the nuclear energy example. The theoretical analysis and its empirical translation include other risk sources from pharmaceuticals to skiing as comparison criteria, in order to cover higher-level patterns of risk perception and risk assimilation. Comparative analysis of different risk sources broadens the spectrum of the perception fields analyzed and allows the discussion of results covering several objects. This book describes, in concise and easily understandable form, the most important results and conclusions of more than two years of research in this field. For those readers particularly interested in this subject, the final report on this research project has been published in six volumes in the form of Jül-Reports by the Jülich Nuclear Research Centre. Most of the Figures have been adopted from this comprehensive version.

The book is organized into five major chapters: Part I presents a critical discussion and summary of the existing literature on risk perception problems, intuitive technology evaluation and nuclear energy attitudes. Part II provides a review of our own theoretical approach and the basic concept used for the empirical analysis. In spite of all our attempts to achieve easy understanding in terms of phraseology and terminology, the two chapters are characterized by social science concepts and, therefore, may be somewhat difficult to follow for readers not experienced in this field of research. Therefore, all the important methodological stipulations are repeated once again in the presentation of the empirical results in Parts III - V, so that readers who are interested only in the results can pass over the theoretical chapters. I ask the reader's indulgence for the resulting, unavoidable redundance in the presentation.

The third chapter is concerned with two social psychology experiments intended to contribute toward clarification of the intuitive evaluation of risky situations. Part IV serves the same purpose. It describes and interprets the results of two comprehensive surveys on the evaluation of different risk sources and their determinant factors. The last part is exclusively concerned with nuclear energy perception and an analysis of attitude components with respect to nuclear energy facilities and their determining quantities. The results presented in this Part are based on a representative survey conducted in five towns in the State of North Rhine-Westphalia, a state within the Federal Republic of Germany.

Finally, the book includes a brief synopsis of the entire study and an index listing and defining the most important concepts.

Publication of this book would have been impossible without the cooperation of Prof. Dr. G. Wiswede, Prof. Dr. E. K. Scheuch and Dr. E. Münch. I am obliged to Professors Wiswede and Scheuch, who supported part of this study as a doctoral thesis, for their critical reviews and many suggestions and improvement proposals. My special appreciation is owed to Dr. E. Münch for his support in the realization of the research project described in this book and for his vigorous support of my work. I am equally obliged to the late Mr. Beyer for the excellent job of translating the German original version into English. Finally, my special gratitude is extended to Mrs. Tanz, who at considerable effort produced this book from my handwritten manuscript.

Jülich, January 1981

Dr. O. Renn

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Foreword

This book is primarily concerned with the perception of technological risk and, in particular, with attitudes toward nuclear energy. In the case of this controversial topic there is the danger of science being forced into a merely palliative role of post-factum justification and rationalization of positions already taken. Therefore, I should like to assure the reader from the outset that the author of this book has exhibited a well-balanced and aloof attitude, and has succeeded well in avoiding this trap and communicating a great variety of differentiated information.

The following problem areas are involved:

(1) risk perception and intuitive risk assessment;
(2) development and structure of attitudes toward nuclear energy;
(3) psychic and social influencing factors which are the causes of these attitudes.

The author initially discusses perception and acceptance for different risk sources on a quite general basis. Risk acceptance is defined as a cognitive process of weighing between subjectively weighted benefits and detrimental consequences. Previous studies on risk acceptance are critically discussed and found to be excessively limited. The author's own approach leads to a phased model consisting of the following steps: Collection of relevant cognitions on risks, attribution of subjective probabilities to these cognitions, weighting of these probabilities and comparison of these weighted cognitions.

In order to determine the ranking of (naive) perception and acceptance of risks the author proposes an additional comparison to a type of objective risk measures, using the expert evaluations as a basis. But such a comparison is highly problematic since everyone knows how often the experts have been wrong in this branch of the natural sciences and how often they hold different views. Moreover, everybody knows that many imponderables enter into the quasi-objective risk evaluation of an expert. Apart from the problematic basic questions (Who is an expert? To what degree is he an expert? To which group does he belong?), and apart from the risk evaluations which are difficult to grasp and often can be weighted only arbitrarily, the problem in the final analysis involves a finite selection of possibilities and occurrences which can be included in the calculation and, finally, finite propagation paths with respect to detrimental consequences: it is impossible to calculate probabilities of the occurrence of events of which nobody has ever thought before. The author is quite aware of these reservations with respect to "objectivity", but would not forgo this field of reference of the quasi-objective evaluation of the experts, because otherwise the naive perceptions of laymen and the calculations of experts would be compared on a level of equality. Rather, Renn attempts to develop the gradual differences in reality content by means of a model of graduated rationality in the perception of risks, which can certainly be considered a pace-setting achievement.

The empirical analysis itself is concerned with perception processes of risk sources and with the development and structure of attitudes, specifically with respect to nuclear energy, as well as the internal and external factors which influence these attitudes. The implementation of the empirical study - ranging from its operationalization, which was sometimes extremely difficult and complex, all the way to the well-balanced interpretation of the results - reveals mastery of the methodological instruments of the social sciences. Some of the results confirm previous studies, while others go far beyond the present state of the art and reveal a great variety of interesting data. For instance, one important information item is that nuclear energy opinions are highly affected by emotions but are still ambivalent to the large majority. This result also appears to reflect international aspects since comparable data from the United States and Japan also demonstate this ambivalence and rigidity of the opinion body. In contrast to the picture broadcast by the media it is also characteristic that most of the nuclear energy opponents feel isolated and that - in a resigned attitude? - they do not believe in the necessity of nuclear energy but are nevertheless convinced that it will come about in the Federal Republic of Germany, regardless of whether the citizens want it or not. Insofar it appears that these results represent an important correction to the widespread opinion that the opposition to nuclear energy is straight-lined and uncompromising.

The author has presented an empirical study which ranks at the very forefront of the presently topical scientific discussion and is probably the best-founded study of this subject at present. On the other hand, the author in his mastery of the sophisticated methods of empirical social research and, at the same time, of socio-psychological and sociological phenomena, proves to be a good advocate of interdisciplinary, problem-oriented research.

Cologne, January 1981

Prof. Dr. G. Wiswede
Cologne University

Summary

Previous studies on risk perception by the population have been based predominantly on three methodological concepts:

- the descriptive decision analysis model
- the model of risk-specific perception influence factors such as voluntariness or personal control, and
- the attitude model.

The main emphasis of studies conducted to date has been in the field of perception-specific risk approaches which, on the one hand, were developed quasi indirectly in the "Revealed Risk Analysis" from the history of the acceptance of risk sources (approach by Starr) or, on the other hand, measured by direct surveys with a view to their significance (approach by Fischhoff et al.). Studies on the attitude concept, which is largely pursued by the IAEA Risk Assessment Group in Vienna, relate more strongly to the cognitive structure of risk perception. Finally, decision analysis studies are presently being conducted at the University of Southern California (von Winterfeldt,Edwards), dealing with the value conceptions of relevant groups in the nuclear controversy, where the perception of risk aspects is being understood as an attribution process of prior value commitments to concrete risk objects.

On the basis of these studies, our aim was to develop an integrative approach to the measurement of perception patterns for a variety of risk sources. The relevant theoretical starting point was a mental risk decision model intended to observe and empirically cover the process ranging from information uptake to the behaviour intention in respect of the object in question. The individual stations of risk perception were characterized as follows:

- information uptake,
- the forming of general beliefs,

- the attribution of probabilities according to the degree of one's own involvement and typical patterns of generalization,
- the evaluation of beliefs by means of attributive biases, qualitative risk characteristics and dispositive as well as situative factors,
- the internal coordination of beliefs (consistence finding)
- the acceptance decision,
- the forming of an attitude and of behavioural intentions resulting therefrom,
- the immunization of the attitude against inward and outward doubts (rationalizing).

For the empirical transformation of this concept, two different comprehensive interviews to elucidate belief patterns about various risks and their weights, two socio-psychological experiments on the significance of qualitative risk characteristics and one representative survey on attitude formation and its determinants were conducted in the Federal Republic of Germany. Part of the questions were selected so as to permit direct comparisons with parallel American and French studies.

The results of this very extensive study, comprising two years of research, may be summarized as follows:

- Most of those interviewed possess relatively homogeneous evaluation criteria for an intuitive risk assessment and arrive at similar results in the evaluation of risk-benefit relations for different risk sources. The classification of risk sources according to the level of their overall risk practically does not reveal any regional, temporary of stratum-specific differences. Even a comparison between the populations in the United States and the Federal Republic of Germany results in similar patterns of risk estimation.

- Although most of those interviewed can reflect relatively well the expected values of losses (fatalities, injured persons, damage to property per year), these estimations are taken as evaluation criteria for the risk-benefit estimation to a minor extent only. The evaluation of risks is governed essentially by the following factors:

  - perceived consequences of a risk source for oneself or close associates,
  - perceived consequences relative generally to health, safety and future scope of freedom,
  - personal possibilits of influencing the risk,
  - the possibility of far-reaching and fatal losses,
  - the personal readiness to take risks.

  The first two aspects were defined as cognitive, the following two aspects as qualitative risk characteristics, and the fifth as dispositive risk propensity. With the aid of these five variables, between 44 and 72% of the variance of the risk-benefit estimation could be explained, depending on the risk source.

- Demographic and social characteristics play a subordinate role in the evaluation of risks. Only the sex of those interviewed has an influence on perception, however not directly, but via the devious path of "special sensitivity to risk consequences relative to health and genetics" and "personal risk propensity". Cognate attitude patterns and general value orientation are of significance only if the associations with the risk source are concerned primarily with risk consequences for the economic,society and future life style. This is the case, for instance, in connection with nuclear energy and plant-protective agents, but not in connection with coal energy, computers (despite the problems of data protection) or X-ray equipment.

- The nuclear energy risk has a particularly ambivalent perception structure due to attributive biases, on account of the negative, perceived qualitative risk characteristics (non-voluntary, high hazard potential) and because of the fear of long-term damage possibilities which cannot be recognized today. Although the majority of those interviewed was convinced of the fact that nuclear energy is an economic necessity and will play a significant role for the future supply of energy, they argue, however, that it involves completely new risk dimensions and cannot be calculated in a scientific analysis.

- This ambivalence has left the basic proponents of nuclear power with a dissonant attitude structure, i.e. the beliefs of those interviewed are very inhomogeneous and, in part, contradictory. Their behaviour intentions are accordingly limited, and their doubts about themselves are particularly pronounced.

- Determined opponents of nuclear energy, on the other hand, are neither convinced of the economic necessity nor of the harmlessness of the risk. They possess a very homogeneous attitude structure and, accordingly, a stronger behaviour motivation. They exhibit, however, a pronounced resignative belief that "it is too late for the nuclear case now" and that, in the long run, they can no longer do anything to prevent the expansion of the nuclear energy sector. This pessimistic view of the future was defined by us as reality stress. It often has a socially destabilizing effect, expressing itself, for instance, in a disintegration from society (withdrawal from society) or, on the other hand, by rigorous activism.

- The possibilities of a meaningful dialogue between proponents and opponents of nuclear energy are by no means exhausted. Both the opponents and proponents of nuclear energy are still rather inclined to trust in the statements of expert scientists as long as these cannot be clearly identified as representing the interests of industry. Moreover, in the case of the proponents, a special dependence on pro-nuclear reference groups is to be observed which, no doubt, is based on the fact that they, in particular, seek the support of others due to their ambivalent attitude structure. The opponents have less confidence in institutional reference groups and feel more strongly attracted to information groups (e.g. local environmentalists).

As a recommendation for continuing the dialogue between proponents and opponents of nuclear energy, we consider it necessary that the topics of such conversation should rather be oriented to the perceived consequences of nuclear energy utilization than to the discussion of risk expected values, which are in any case little contested.

Part I

Risk Perception and Acceptance:
A Bibliographical Review

Systematic Summary of Different Research Concepts

The problems involved in the risk acceptance of nuclear facilities in almost all western industrial nations has resulted in an avalanche of psychological and social science literature devoted to the questions of the development, origins and consequences of the present risk acceptance crisis. In spite of this broad spectrum of available scientific analyses most of these studies have been limited to the application or transfer of sub-theories to the present-day situation and attempt, on the basis of a particular theoretical perspective, to describe the nuclear energy conflict and reveal its causes. On the other hand, generally oriented and interdisciplinary studies on a broad empirical basis are rarely encountered.

A brief selection of some important research concepts and theories on risk acceptance and nuclear energy conflicts will be presented in this chapter. It goes without saying that a selection of this type can never be comprehensive or representative; rather, it is the objective of this description to provide a systematic review of the broad spectrum of scientific literature available and comparative explanations of the intentions and results of studies accomplished to date. This review does not include publications which also provide a summary of existing concepts but do not represent original theories of their own (cf., for instance, von der Ohe, '79, 288; Paschen, '79, 307). [Quotations are ordered in the following manner: author, year of publication, number in alphabetic index.] In accordance with scientific conventions and the personal categorization of the authors, the individual studies will be classified into the following scientific fields:

- economics-oriented concepts;
- decision analysis concepts;
- risk theory concepts;
- individual psychology concepts;
- social psychology concepts;
- sociological and political science concepts.

Table 1 contains a systematic classification of concepts and their most important proponents. This list, of course, is incomplete, and the classification is often problematic. However, it appears suitable and sufficiently accurate for an initial orientation on the spectrum of possibilities.

Table 1:
Systematic Classification of Explanatory Concepts

Scientific field of classification	Theoretical framework	Summary description of the concept	Proponents (selection)
Economics	Marginal utility theory	Determination of marginal cost and utility, comparison of individuals, groups and society	Felix Renn
	Economic theory of politics	Demand maximization via resource mobilization, political influence	Downs, Frey, Titz
Decision analysis	Normative risk assessment	Optimum procedures for cost and benefit estimation, risk minimization and selection of alternatives	Rowe, Lowrance, Kates, Fischhoff, Sagan
	Normative decision-making theory	Optimization of procedures to guide decision-makers to the most rational decision possible	Coombs, Okrent, Raiffa, Edwards
	Descriptive decision-making theory	Definition of the determinants of the factual decision-making process	Janis/Mann, Pollatsek, Tversky, Vlek, Stallen, Kogan, von Winterfeldt Jungermann

(contd.)

...entific field ...classification	Theoretical framework	Summary description of the concept	Proponents (selection)
...k theory	Revealed preference analysis	Past risks as indicators for the evaluation of new risks	Starr, Cohen
	Referred or expressed preference analysis	Empirical determination of risk elements through surveys	Fischhoff, Slovic, Lichtenstein
...chology	Psychoanalysis	Transfer of psychoanalytical concepts and archaic types to the underlying causes of nuclear energy attitudes	WHO Report, Schild, v.Erichsen, Wünschmann, Tubiana
	Psychological reduction theory	Transfer of psychic mechanisms to the perception of nuclear energy	Pahner, Pelicier
...ial psychology	Risk perception	Perception effects in risk assessment (attributve biases)	Maynard, Tversky, Fischhoff, Slovic, Vlek, Kogan, Bierbrauer, Frantzen, Schmid-Jörg (Battelle)
	Risk socialization	Learning of interpretation patterns for risk evaluation	Gutmann (Battelle) Cohen/Hansel
	Attitude concept	Attitude toward the subject requires risk acceptance	Otway, Niehaus Davis, (v.Buiren) Fishbein
	Communication concept	The conflict is the result of misguided and distorted communication	Goerke (Eisenbart, Crebsbach)
	Symbolic reduction theory	The nuclear energy conflict is representative for symbolic societal or psychological issues	Röglin, Dumenil, Hofstätter

(contd.)

Scientific field of classification	Theoretical framework	Summary description of the concept	Proponents (selection)
Sociology	Sociology of the sciences	Conflicts are the result and expression of scientific orientation processes	Nowotny, Tschiedel, Nelkin, Weingast
	Empirical-functionalistic concept	Conflicts are functional/dysfunctional for future value orientation	Lübbe, Schoeck Douglin, Tognacci,
	System analysis concept	Crisis in the interchange relationship between nuclear system and political periphery	Battelle, BMFT II Study Gripp
	Conflict theory concept	Dispute represents conflict of interests and participation	Scharioth, Paschen, Andritzky Nelkin, Kitscheet
	Normative-democratic (participatory research)	Conflicts lead to more democracy	Schumacher, Moßmann, Gladitz
	Neo-Marxism	Conflicts are caused by class contradictions and capitalistic crises	Offe, Metz
	Orthodox Marxism	Conflicts are caused by the realization of monopolistic capital exploitation interests	Lob

The overall matrix seen from this Table exhibits a very broad spectrum of concepts whose internal logic frequently predetermines the approach and sometimes even the results. It would be beyond the scope of this study to discuss in detail each of these concepts and to subject them to critical examination. However, it seems important to summarize briefly the basic concepts underlying the existing studies and to highlight the spectrum of questions which have remained unresolved.

Decision Analysis and Risk Theory Concepts

Normative Decision-Making

Decision-making and risk theory studies are motivated either by the problem as to an optimum procedure for selecting the best option from a number of alternatives (normative theory), or by the problem of describing the actual selection process, i.e. describing how individuals, groups or institutions select an option (descriptive theory). In addition, reference is made to a so-called explicative theory which has been used to develop the mathematical and logical framework for rational decision-making and sometimes also to a typological theory which, in a manner of speaking, involves a systematic identification and classification of all types and possibilities of decision-making.

The distinction between normative and descriptive or explicative and typological decision analysis should not be understood as implying strict compartmentalization. Even the development of proposals for rational decision-making cannot forgo the subjective evaluation of alternatives for action. Also, the description of actual behaviour must be based on certain logical assumptions of behaviour because otherwise the typification or generalization of behaviour patterns would be impossible. Rather, this distinction applies to the purpose of a study: either to give decision-making aids or to define existing forms of decision-making.

But how do these theories relate to the problem as to the risk acceptance of nuclear energy? Without presenting a definition of risk acceptance at this early point it appears to be intuitively evident that any consideration as to the acceptance of risk represents a decision-making problem. Is the probability of negative effects worth the benefit associated with the source of risk? In order to respond to this question the likely procedure is to collect the risk aspects, to weight them with the probability of their occurrence and to compare them to the benefit aspects. The result of this balancing process is a risk acceptance decision.

Let us first consider the proposals presented in the literature to justify normative risk acceptance thresholds, i.e. the determination of a point where risk acceptance appears justified. The great variety of existing solution models can be reduced to seven basic variants. These include the following:

- The arbitrary establishment of a risk acceptance threshold on the basis of plausible considerations (such as the use of production processes optimized for safety engineering), natural standards (such as the natural radiation level) or the dispersion spectrum of a potential type of detriment which can be found in nature (such as the difference between the radiation levels in the Black Forest and in the North German Plains as a measure for the maximum acceptable risk) (Rowe, '77, 349, p. 74 ff.);

- The quantification of benefit and risk. Risks are considered acceptable when the value of their benefit covers the potential detriment. However, the value of different benefit and/or detriment dimensions must be defined subjectively (Fischhoff et al., '79, 114, p. 18 ff.) to allow their comparability and intercomparability.

- The marginal cost analysis of risks (cost-effectiveness). Under this concept the expected cost of the risk is compared to the cost required to reduce the risk. The risk acceptance threshold can be defined as that point where the marginal cost is identical for both cost types. Since this concept, too, requires a subjective evaluation of different cost dimensions in order to obtain a yardstick for comparison,Black et al. proposed to use only health detriment as the unit of measure and to select that point on the cost curve where the expected losses caused by the risk source are equal to the expected losses caused by the adoption of safety measures (Black et al., '79, 481, p. 5 ff.). While this method allows rational decision-making as to the limits up to which safety devices are still justified, it fails to provide any indication as to whether the risk source as such is acceptable;

- The historical definition of a risk acceptance threshold (revealed preference analysis), using as a yardstick the manner in which society has accepted risks in the past. Risks which are not greater than risks accepted in the past may be considered worthy of acceptance (Starr, '69, 405, p. 1232 ff.);

- Empirical surveys of decision-makers or of relevant groups among the public to identify preference structures in relation to risk. In this theory, potential risks are quantified and individually presented to decision-makers for voting and evaluation so that subjective estimations are always taken into consideration (Social Judgement Theory; Hammond et al., '75, 494). At the same time, parallel sensibility analyses are conducted to determine the spectrum of possibilities and alternative structures of risk effects through surveys;

- Weighting of risk consequences through empirically determined, qualitative risk criteria. This so-called "referred preference analysis" is used to determine, through general surveys, the basic types and criteria of risk evaluations, to identify the perception and evaluation of different risks and to pass on the results to decision-makers as a basis for their risk assessment (Fischhoff et al. '78, 112, p. 127 ff.). Although the empirical studies have been conceived as a means for the optimization of decision-making processes, they also provide a good insight into the process itself and the determinants of risk perception.

- Elicitation of underlying values from groups involved in the decision-making process and breaking down of the values into dimensions, sub-dimensions and detailed specifications until a level of measurable attributes is reached, on which alternatives can be evaluated by measurements, judgements or both (Value Tree Analysis). This technique is part of multiattributive utility measurement and is aimed at finding an overall utility function for different conflicting groups. This very new method has not yet been worked out in all its details, but appears to be very promising for combined normative and descriptive decision analysis (v. Winterfeldt et al., '80, 533, p. 3 ff.).

Descriptive Decision-Making

The expressed risk analysis and the value tree technique already complete the transition to descriptive risk analysis. In the extreme case the decision-maker is expected to base his political judgement on the empirically determined risk preferences of the population. But what are the preferences of the population and how are they structured? Two different approaches are available to respond to this question:

- The mathematical-axiomatic representation of actual risk acceptance behaviour with reference to formalized risk and lottery games using the two basic variables, the probability of winning or losing in a lottery and the distribution of expected values;

- The systematic, empirical identification and description of the decision-making process in "genuine", true-to-life risk problems involving an incalculable number of effective variables.

Again, a brief description of the different concepts and their explanatory value appears necessary. The mathematical-axiomatic models will be discussed first:

- The perceived risk is equivalent to the probability of winning or of losing a certain amount of money (Expected Value Theory). This classical risk perception theory is now considered disproven by empirical evidence.

- The perceived risk is equivalent to the product of the probability of loss and its benefit evaluation. This theory was put forward by the economists Domar and Masgrave (44, 487, p. 388 ff.). It, too, is considered disproven today (cf. Vlek, Stallen, '79, 529, p.3).

- The perceived risk is equivalent to the product of the subjective probabilities of benefit and loss and their individual weighting (Subjectively Expected Utility, SEU). To this time, SEU theory is used as a basic model of risk perception, but its empirical relevance is highly disputed since the subjective weighting has the result that any experimental result can be considered as confirmation for the SEU theory. It fails to meet the falsifiability postulate (cf. Kogan, Wallach, '72, 504, p. 137; Svenson, '75, 525, p.187 ff.).

- The perceived risk depends on the variance of probability distribution and is independent of the expected value of the lottery (Coombs, Pruitt, '60, 484, p.265 ff.). The model is no longer propounded with this rigidity today (Coombs, '72, 60, p.5 ff.). Even modified versions (greater weighting of the loss variance or semi-variance models) were not convincing under empirical aspects.

- The perceived risk is equivalent to a linear combination of expected values and variance (cf. Pollatsek, Tversky, '70, 516, p.547). The subjective weight of the two influencing variables is considered to be a free parameter. Existing empirical studies have not, or only partially confirmed this theory (cf. Coombs, Bowen, '71, 485, p.27 f.; Payne, '75, 515, p. 86 ff.).

- The perceived risk cannot be mathematically determined because there are certain concepts on equivalence relationships between alternatives but no clearly transitive ranking order. Individuals will evaluate risks on the basis of a single-peaked preference function and a subjective risk ideal, and two decision-making theorems are stipulated:
  1. Out of two lotteries having the same expected value, that lottery is selected which has the smaller variance.
  2. Out of two lotteries having the same variance, that lottery is selected which has the greatest expectance value (Portfolio Theory). This theory has been tested empirically on several occasions and has been proved to be basically valid (cf. Coombs, '72, 60; Schäfer, '78, 380, p.40 f.). However, in spite of the mathematical elegance of the axiomatic derivation of this portfolio theory, the question remains as to whether it does not expend great efforts to prove the trivial discovery that individuals subjectively judge risky actions according to internal preferences and optimize the remaining factor.

- The perceived risk results from the combination of an evaluation function of opportunities and a preference function of risks (Krelle, '68, 507, p. 140 ff.). The salient characteristic of this theory is that a distinction is made between subjective benefit evaluations and risk attitudes (Schäfer, '78, 380, p. 32). Quite apart from some theoretical problems, this concept has not been empirically validated to date (Schäfer, '78, 380, p. 33 and p. 41).

Still other models have been devised, but most of these represent only intermediate concepts between the variants described above. Therefore, we feel that this list will suffice for a brief review of the field. The primary purpose of presenting the characteristics of these concepts was to point out that the process of theory development in the mathematical estimation of empirical risk assessment is not yet complete and, at the same time, to demonstrate the limited information content and artificial nature of these concepts. The transfer of laboratory experiments to real risk situations, the highly hypothetical experimental arrangements which are especially susceptible to systematic errors (response sets), the absence of a realistic emotional or motivational decision-making pressure and the occurrence of ambiguous results in the testing of these theories are in themselves sufficient to restrict the application of these concepts for the development of social science theories to very few cases. The principal argument is that the limited scope of the experimental situation (hypothetical game of chance) and the limitation to the calculatory quantities of probability, winnings and losses do not allow any generalization of results, not even to include "genuine" games of chance (cf. Vlek, Stallen, '79, 529, p. 4 f.; Schäfer, '78, 380, p. 38 ff.; Sjøberg, '77, 522, p. 8 f.; Kogan, Wallach, '72, 504, p. 137 f.). And it is even more open to doubt whether the results of these experiments could represent something in the nature of universal risk evaluation criteria. Both the studies in the field of insurance risk (cf. Slovic, '78, 369, p. 58 ff.) and the results of risk research in the consumer field (cf. Cunningham, '67, 486, p. 84 ff.; Bettmann, '73, 480, p. 184 ff.) make it a natural assumption that the influencing factors of risk perception vary between different subjects and situations.

As a counterbalance to the mathematically oriented decision-making theories a number of process-oriented models have been devised in the meantime where risk perception and acceptance are considered to be functions of information processing and evaluation and of the resulting conflicts. Again, some basic types can be identified among the great variety of models on the basis of their underlying concepts and/or fields of application:

- Models of cognitive stress and common sense reasoning;
- Models to describe the decision-making process;
- Models for subjective weighting of consequences;
- Integrative risk perception models.

All four types of model will be described in detail, below:

- The concept of common sense reasoning and its biases is based on the question as to how a multitude of complex information items can be reduced to major notions (salient beliefs). The empirical approach consists predominantly in assigning problems to test subjects which can be objectively resolved (on a logical or statistical basis), and explaining the subjective deviations from the "correct" solution as a consequence of "erroneous conclusions" (biases). A great variety of distorting mechanisms in information processing have been identified experimentally: individuals will structure randomly distributed events on the basis of a content pattern (in games of chance, for instance, based on the idea of poetic justice); in developing their conclusions they are excessively self-confident and fail to recognize the laws of statistical regression; they tend to overestimate the dependability of the occurrence of events when the events are still fresh in their memory (availability) and when they have correctly predicted them on an earlier occasion (learning effect); finally, they tend to prefer alternatives which are subject to a lesser degree of ambiguity in their expected value, although this means that, objectively, they accept a higher risk (in this case, reference should be made only to the summarizing references: Ross, '77, 346, p.280 ff.; Sjøberg, '77, 522, p. 9 ff.; Slovic, Fischhoff, '79, 370, p. 6 ff.; Cohen, Hansel, '61, 483, p. 17 ff.).

- The concept of describing the decision-making process attempts to clarify the individual decision-making phases, the balancing of consequences and the strategy of information processing. The starting point for most theoretical models of this type is the time dimension. Since decisions have to be made within a certain period of time, individuals in a group are forced to resolve, through certain strategies, the conflict existing between the time-consuming acquisition of information which would provide more dependability and the urgency of the decision (in terms of economics: the opportunity cost of waiting) (cf. Miller, Starr, '67, 514, p. 60 ff.). The following procedures have been conceptualized as decision-making strategies:

- Threshold value analysis (Satisficing Strategy). This means that individuals will check each consequence as to whether a threshold value considered necessary is exceeded (cf. Simon, '76, 521, p. 83 ff.). But this model must fail with a great number of alternatives and consequences because a rule for the selection of the optimum variant does not exist.

- Satisfying K.O. conditions (Elimination by Aspects). The variants requiring a decision are screened against a graduated K.O. system of conditions until that variant remains which satisfies most of the conditions (cf. Tversky, '72, 527, p. 281 ff.). Although this concept may be quite meaningful and close to reality in the case of some product decision-making (such as purchasing a motor car), it cannot escape the danger of the ambiguity of results or the constraints of a strict ranking order of K.O. conditions which is hardly feasible in reality.

- Muddling Through. A noncommittal sub-decision (such as asking someone to dance) results in a new social situation which in turn causes a reaction of the environment (such as an attachment, a request for another meeting etc.) which in turn requires further decision-making (whether or not to meet again). Following a number of additional ad-hoc decisions,the social situation narrows to the point where a fundamental decision, not originally intended, becomes necessary (such as marriage). This form of "stumbling" into decisions is considered predominantly a characteristic of bureaucracies in democratic societies since the reaction of the societal institutions continuously modifies the sub-decision-making process (cf. Lindblom, '59, 511, p. 79 ff.).

- Pursuit of sub-objects by rational decision-making while showing consideration for external influence groups (Mixed Scanning). This concept is intended to indicate an intermediate approach between the optimization of action alternatives and a continuous, reactive transformation of these objectives and means on the basis of social influences, where the rational selection of alternatives must always be measured against the democratic realization potential of these strategies (cf. Etzioni, '67, 491, p.387 f.).

- The balance model of conflict theory. In this model the variables of "time constraints", "utilitarian gains and losses for oneself and others", "perception and evaluation of alternatives", "approval or disapproval from significant other" and "congruity with self-perception" are varied systematically in order to analyse the expected consequences and reactions of individuals for all the possible combinations (cf. Janis, Mann, '77, 499, p. 70; 86, p. 137 ff.). In particular, the mechanisms of stress reduction are problemized through the displacement of regrets, post-decisional justification (rationalization), selective information input and cognitive striving for consonance (bolstering) (cf. p.91 ff., p.144 ff.). The two authors define the overall model not only as a description of the actual decision-making process but even more so as a theoretical reference frame for the entire spectrum of decision-making situations.

- The concept of subjective weighting of consequences represents an attempt to investigate the types of consequences involved in decision-making and their weighting by the subjects. Unlike the cognitive stress models (Type 1), this does not concern the problems of distorted or erroneous perception but personal values, preferences and aversions used by individuals to evaluate alternative actions. It is not by chance that this theoretical approach is predominant in market research because the purchasing behaviour of individuals is decisively determined by a subjective pre-evaluation of the consequences of making a purchase. Again, some basic models can be summarized:

- The two-component model by Cunningham (cf. '67, 486, p.82 ff.). This concept means that the purchase decision is determined by the product of the perceived hazards of the purchasing consequences and the subjectively perceived degree of uncertainty inherent in these consequences.

- The two-component model by Betmann (cf. '73, 480, p.185 ff.). It means that the decision can be explained by the strength of the belief in positive or negative consequences and by the personal significance of the different consequences.

- The multi-component model by Kaplan et al. (cf. '74, 500, p.287 ff.). This approach typifies the consequences and classifies them in accordance with the criteria of instrumental utility, financial losses, social reactions, psychological effects and physical safety risk.

- The multi-component factorial model by Schweiger (cf. '76, 526, p.26). This model further differentiates between the criteria of the model presented by Kaplan et al. on the basis of the additional components of "subjective uncertainty" and "importance".

All four of these models have so far had little effect on the scientific discussion of risk acceptance. Moreover, some of them are highly controversial from the empirical point of view (cf. von Rosenstiel, Ewald, '79, 518, p.95 ff.).

- The concept of integrative risk perception is based on the impossibility of constructing risk perception components. In reality, it is stated, man evaluates risks exclusively on the basis of an inner, one-dimensional evaluation scale (judged seriousness of risks). For instance, Wilde holds that each individual has a constant risk threshold with reference to risky activities (cf. Wilde, '78, 530, p. 134 ff.). Starr's Revealed Preference Concept (refer to Page) also matches this concept on a higher level. One general objection to this model type is that it creates an artificial "black box" and, consequently, is interested merely in the result of weighing risks but not its causes and influencing factors. At the same time it lacks an empirically validated basis for the stipulation of an individual or societal risk acceptance threshold. However, this concept is interesting in that it allows the study of dependencies on third variables such as social or demographic data with the aid of a risk evaluation scale. Kogan and Wallach conducted an experiment to study the effect of perceived self-value (ego-defensiveness) and the degree of anxiety on risk acceptance and concluded that both variables are significant factors (cf. Kogan, Wallach, '64, 503, p.190 f). However, other experiments have so far failed to reveal additional evidence to the effect that personality characteristics have an effect on risk evaluation (cf. Kozielecki, '74, 505, p.3 ff.).

Conclusions on Risk Theory and Decision Analysis

A review of the great variety of risk and decision-making theory concepts will reveal a dicrepancy between the mathematical models which are highly formalized and complex, but far from reality, and the partial, often poorly structurized but empirically more relevant procedural models. The following conclusions for the theoretical and empirical concept have been drawn from the existing studies on risk perception and decision analysis:

- Risk perception is based only partially on the numerical quantities of "subjective probability estimation" and "expected values" and is not determined by SEU theory.

- Decision-making on risks is strongly affected by cognitive stress factors such as complex information processing, decision-making under pressure of time, uncertainty as to potential consequences etc.

- Risk perception and evaluation are not based on a standard risk-weighing pattern but are specific for classes of risk sources and dependent on subjects and situations.

- The question as to whether some generally applicable risk evaluation strategies do exist and the degree to which personal characteristics correlate with these specific strategies, has not been clarified to date.

- Other problems which appear to require clarification include a typology of risk consequences, the question as to its internal weighting or its effect on the perception of the overall risk, the problems involved in psychic processing of the uncertainty factor and the effects of additional risk-specific variables.

These insights are used for both the basic theoretical concept and the interpretation of empirical results for the purposes of this study. However, the risk theory concept on the whole proves to be too narrow for use as the sole basis of further analysis. Therefore, a review of the economic, psychological and sociological concepts is also required in order to develop additional information.

Economic Concepts

The explanation of risk acceptance by the economic models follows closely the reasoning of decision-making theory. Two concepts exist so far which purport to describe and explain the risk acceptance of technological innovation on the basis of economic theories:
- the marginal utility concept,
- the "New Economic Theory" concept.

Using the analogy of product purchasing where the consumer relates the potential utility of the last-consumed unit to the resulting cost and makes his purchase decision on that basis, the marginal utility concept compares the additional utility of the risk source for nearby residents to the subjectively perceived marginal risk of the source, and strikes the balance of these two quantities. Although numerical quantification of these two components is hardly possible, this concept has the advantage of creating a universal starting concept which facilitates systematic structurization of the empirical results and their interpretation. If one subdivides the elements involved in each balance between utility and risk into direct elements (such as financial losses or advantages), indirect elements (such as detrimental effects on health or improved infrastructure), symbolic elements (such as loss of status or greater social prestige) and distributive elements (such as relative income losses or advantages to certain groups) it is seen immediately that the different agents of a society such as individuals, groups, institutions etc. also attribute different weights to these elements when they determine their marginal utility. For instance, in the case of major technologies the individuals will start out predominantly from the indirect advantages and disadvantages while groups tend towards placing more emphasis on distributive elements and decision-makers tend to see primarily symbolic and direct elements. This results in a rationality gap between the different levels; for, although each of them takes the most rational decision on the basis of his own utility maximization, the result does not tend in the same direction (Renn, '79, 333, p.161 ff.).

The economic theory of politics model is based on a similar concept: each individual and each group attempts to maximize advantages and minimize disadvantages in the most rational manner possible. However, different ways of life, interests and economic situations result in different risk notions in each instance. Downs attempted to prove that it is especially the ecology and environmentalism topic which, due to the existing structure of society, will lead to polarization of the utility maximization to be expected. With improving organization of the opponents, this polarization will reach a climax in social conflict until new types of conflict management have been established (Downs, '72, 84, p.38 ff.). Progressing beyond the theoretical description of social conflicts the New Economic Theory, using the analogy of the risk model applicable for market events, considers the political decision-making process an optimization process where the groups of society struggle for relative advantages over other social forces, at the same time evaluating rationally the uncertainty and the risk of failure (Frey,'78, 492, p.214 ff; Himmelmann, '77, 496, p.193 f.). In its basic features this model corresponds to the classical concept of optimization of the expected value and, therefore, remains inferior to the presently developed theories in the field of descriptive risk perception. In particular, the information theory assumptions on which the risk perception of the New Economic Theory is based, are not yet convincing in the light of communications research (cf. the criticism of Abplanalp/ Hettlage, '79, 478, p.259 ff.).

Individual Psychology Concepts

Since the start of industrialization, man and technology have been the subject of philosophical, anthropological and psychological research. The central aspect of these considerations is the problem of the autonomy of technological developments, the resulting material constraints and the feedback effects of these constraints on the psychic assimilation of environment and external stimuli.

It would exceed the scope of this study to review the voluminous literature on this subject. Therefore, only a few studies shall be mentioned here which were concerned specifically with the problems involved in the acceptance of nuclear facilities.

During the very early phases of oppposition to nuclear energy in the 'fifties - this protest exhibits all the characteristics of problems in adaptation to modernization trends and aversions based on experience with nuclear bombs - several attempts were made to explain the opposition to nuclear energy and major technology with psychoanalytical methods. Mythological anxieties (Prometheus), transfer of food ingestion and excretion to food contamination and radioactive waste, and suppression mechanisms in coming to terms with nuclear weapons were cited as problems (von Erichsen, '62, 441, p.161 ff.; WHO Report No. 13, '60, 450, p.14 ff.). In recent times, Wünschmann has retrieved these studies and transferred Jung's archetypal concept to the present-day conflict on solar and nuclear energy (Wünschmann, '80, 460). Wünschmann holds that, in addition to the rational and factually oriented conflicts on the advantages and disadvantages of nuclear energy, the psychically subconscious mechanisms of environmental assimilation are the main causes of the acceptance crisis of nuclear energy. For this purpose he uses the following hypothetical effective variables (Wünschmann, '80, 460, p.25):

Individual Awareness:
- Paragon of civilization which enslaves man;
- Isolation and alienation from nature;
- Cultural and metaphysical rootlessness;
- Suppression of emotional values and intellectual loneliness;
- Lobbying, capitalistic exploitation;
- Dissatisfaction and frustration on the job;
- Fear of a world exclusively determined by reason and will-power.

- Uneasiness and suspicion towards an enigmatic bureaucracy.

Collective Subconscious:
- Archetypal punishment myth;
- Paradise archetype;
- Solar archetype;
- Shadow archetype.

In applying these effective parameters to the nuclear energy conflict, Wünschmann arrives at the conclusion that the association between bomb and nuclear power station, the perception of a monolithic block of a nuclear power lobby, the hope for a riskless solar future and the rejection of anonymous, centralized institutions have caused a subconscious opposition of man towards nuclear energy.

Similar arguments are used by Tubiana ('78, 428) who transferred categories of Freudian psychoanalysis to the nuclear energy conflict. Tubiana postulates that human behaviour is predominantly determined by dogma, fear, tradition and myths. He identifies as particular suppression mechanisms the latent technology fear, nature cult, cognizance myth and fear of indeterminable environmental structures. These four mechanisms, he postulates, cause a back-up of emotions whose energy is then discharged against a symbolic object. Nuclear power stations as symbols for technology, human achievements and unaccustomed types of risk, he feels, are natural targets for irrational and subconscious criticism of everyday problems (Tubiana, '78, 428, p.4 ff.).

Pahner ('76, 305) and Pelicier ('77, 312, p.198 ff.) also attempted to determine some psychic variables which could have an effect on attitudes toward nuclear energy. In this study, the opposition is related to the transfer of personal conflicts to external scapegoats and to the compensation of a lack of orientation in a value-pluralistic society which the individual can no longer handle. We are indebted to Schrenk for pointing out the psychological characteristics of nuclear energy advocates (Schrenk, '76, 398, p.87 ff.). In particular, he characterized the personal identification with technological facilities as an ego-stabilizing orientation toward fixed regulatory structures.

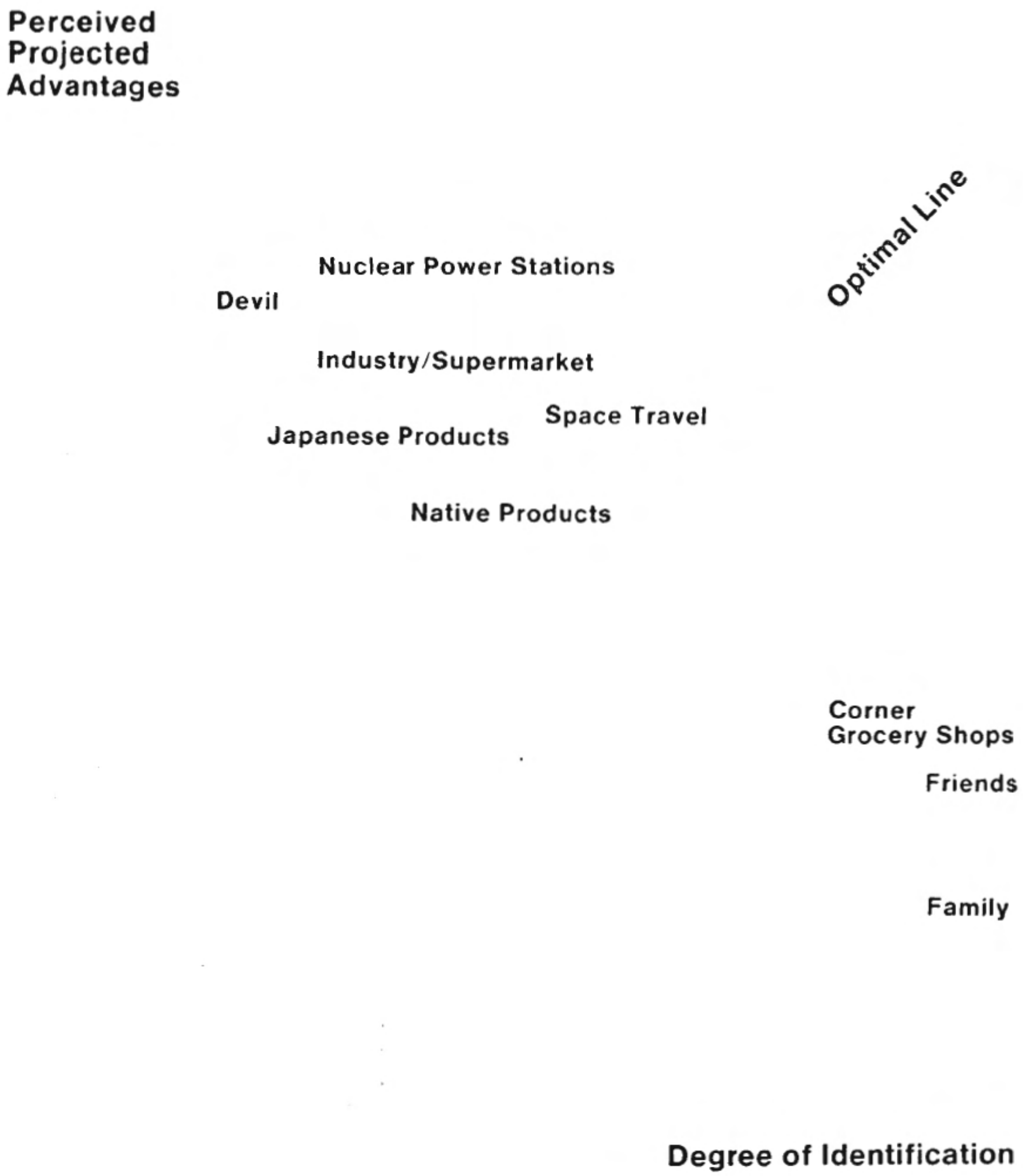
Psychological analyses of the nuclear energy conflict have frequently met the criticism that the emphasis on subconscious motives and suppressed or compensated anxieties insinuates that the groups involved in developing the arguments are irrational and that opposition to nuclear energy is either deviant psychological behaviour or a meaningful protest against the wrong object (cf. Paschen, '79, 307, p.17 ff.; Kitschelt, '80, 532, p.175 f). This criticism certainly appears justified where the psychological approach is used as the exclusive psychological explanation pattern, since both nuclear energy protest and nuclear energy support can be justified with rational considerations, as demonstrated by the marginal utility concept, for instance. On the other hand, it cannot be denied that unconscious or subconscious assimilation mechanisms of risk information predetermine the direction of the developing attitude toward the object in question. However, it is very difficult to determine the proportion of unconscious factors with sufficient exactitude by empirical means. As a rule, these can only be postulated theoretically but are very difficult to demonstrate in empirical studies. Therefore, the present study, whose primary emphasis is on empirical research, has neglected an explicit development of depth psychology arguments without questioning the justification of a transfer of depth psychology theories to the individual technology acceptance process.

Social Psychology Concepts

A fluid transition zone exists between psychology and social psychology so that the classification of the different studies was not self-evident but had to be accomplished on the basis of self-assessment (in the case of Röglin, for instance) or on the basis of scientific conventions. Moreover, they are in close proximity to the descriptive decision-making models.

That most risk acceptance studies have originated in the field of social psychology may also be due to the fact that the individual component of risk perception and the society-oriented component of the social protest movement require a dual approach. With respect to the nuclear conflict, social psychology research has concentrated on two explanatory concepts:
- Acceptance models (symbolic reduction),
- Attitude-formation models.

One very simple, more intuitive model was developed by H. Ch. Röglin (Röglin, '77, 338, p.58 ff.). Röglin's basis is that the nuclear energy conflict is primarily due to a projection of the anxiety-envy syndrome typical of our society to nuclear energy facilities (Röglin, '77, 337, p.21). This syndrome induces individuals to accept only those things which exhibit both problem solution potential (projection) and potential identification with the object (identification). In the case of nuclear energy, there is a large deficit of identification possibilities, i.e. of emotional warmth, so that it is perceived as an alien element and, at best, a necessary evil (cf. Figure 1).


Perceived
Projected
Advantages
Optimal Line
Nuclear Power Stations
Devil
Industry/Supermarket
Space Travel
Japanese Products
Native Products
Corner
Grocery Shops
Friends
Family
Degree of Identification

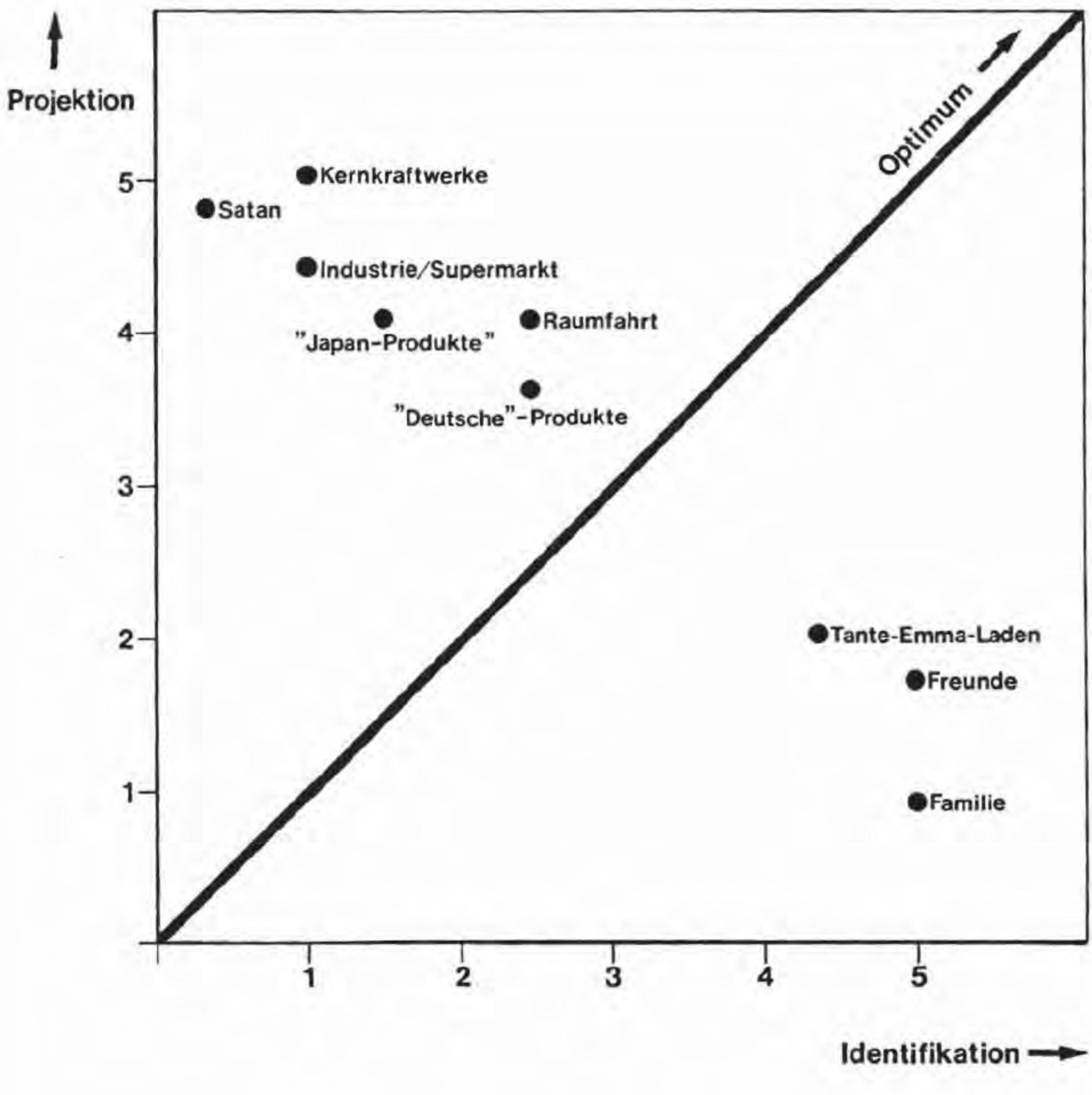


Fig. 1: Risk Acceptance Model in a Two-Factor Psychological Space (cf. Röglin)

Although the plausibility and validity of this model cannot be denied, its theoretical and empirical justification and the spread of the spectrum which can be explained by this model remain obscure; in particular, there is a lack of interpretation patterns to explain the causes of deviations from the midline and their effects.

A similar explanation model was developed by Hofstätter ('79, 172). Based on the observation that individuals attempt a semantic simplification of the characteristics of objects, he transferred the ideas associated with the antonyms of male and female to a dual field of words by allocating highly correlating attributes to each of these two terms. Thus, the attributes active, dominating, strict, serious-minded, but also cruel and destructive are classified under the male generic and, similarly, the attributes passive, emotional, warm-hearted, soft but also untidy and vague under the female generic. Technology and, in particular, technological progress, are predominantly attributed to the male polarity, i.e. they are associated with the attributes clear, well-ordered and sober, but also with destructive and cruel. Hofstätter emphasizes that this is not due to an inherent ambivalence of technology (which is not impossible) but to intuitive simplification mechanisms. Consequently, the ambivalent estimation of technology is not only determined by the object itself but also by people's concepts and prejudices. However, Hofstätter's theory does not allow any statement whether some technologies are forced to justify their existence while this does not apply to other technologies, or only to a minor extent. The explanatory value of this theory consists in the description of an initial semantic situation which is used to filter information. The degree to which this bias becomes equally effective for all technologies cannot be derived from the model.

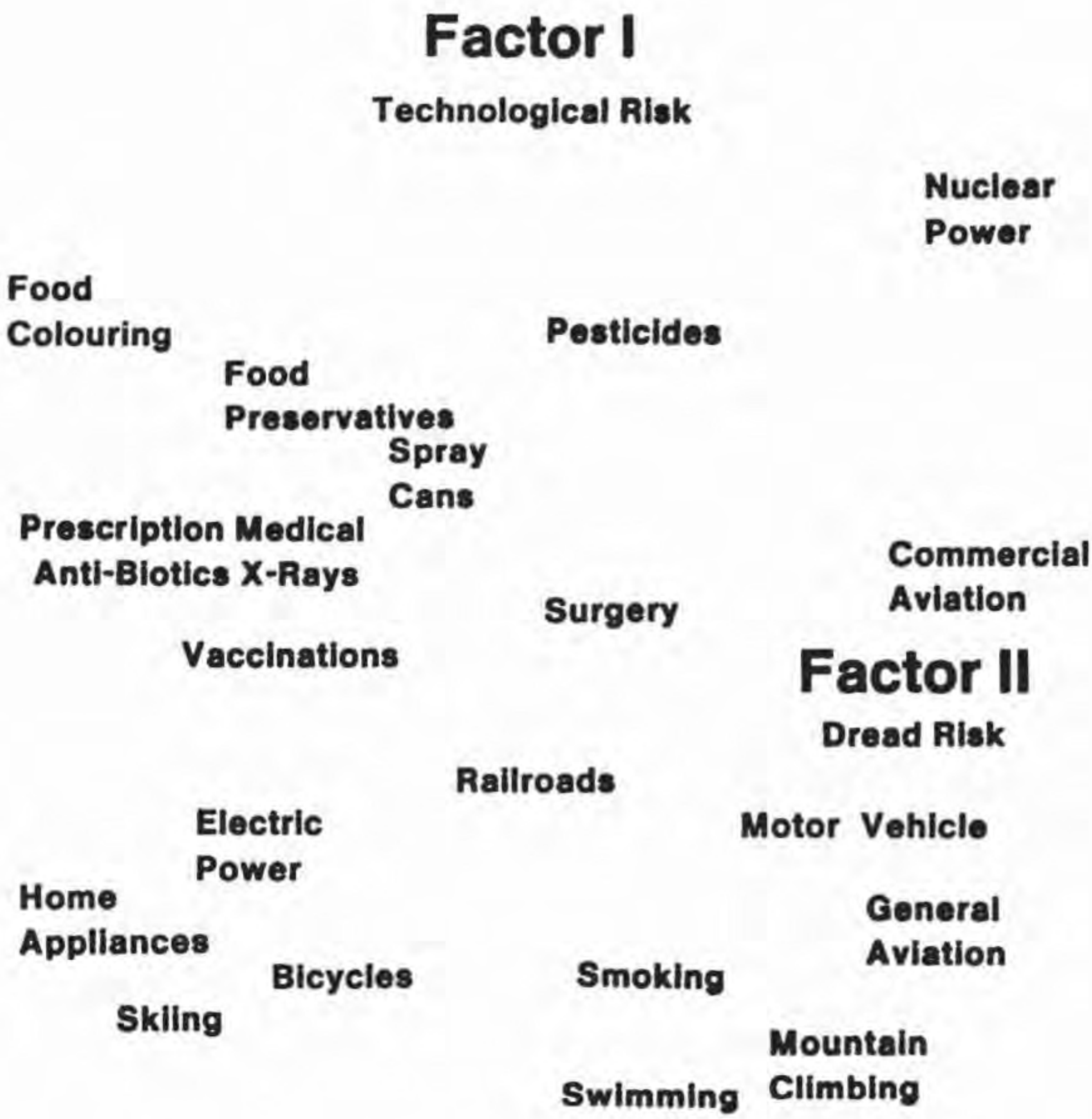
The risk acceptance studies by Dumenil et al. start out from the social role of technology in order to extract psychic factors. Man's attitudes toward a multitude of politically relevant issues with symbolic values (ranging from premarital love all the way to the foreign legion) are measured, correlated and the correlation values, representative of the degree of similarity of the individual issues, transferred to a coordinate system. The authors use the identified dot aggregations in this coordinate system to develop patterns of related issues to which they assign appropriate labels. Empirical application of this model revealed a positive correlation between the attitude towards nuclear energy on the one hand and a conservative attitude toward life and preference for a "strong" government on the other (Dumenil, '77, 85, p.97 ff.; Agraphiotis, Pages, '77, 3, p.139 ff.). For Dumenil and his collaborators the attitude toward nuclear energy is merely symbolic of biased socio-political perception patterns used to evaluate new phenomena on the basis of an inherent code.

This interpretation is based on the concept that the inherent characteristics of an object and their individual perception have hardly any effect on individual attitudes. The independence of attitude development on the characteristics of an object which is postulated by these authors cannot be maintained on the basis of existing theoretical analyses and empirical studies. At least this concept fails to clarify why - of all things - nuclear energy has become the symbol of an entire popular movement, and not supersonic aircraft, industrial robots or oil refineries.

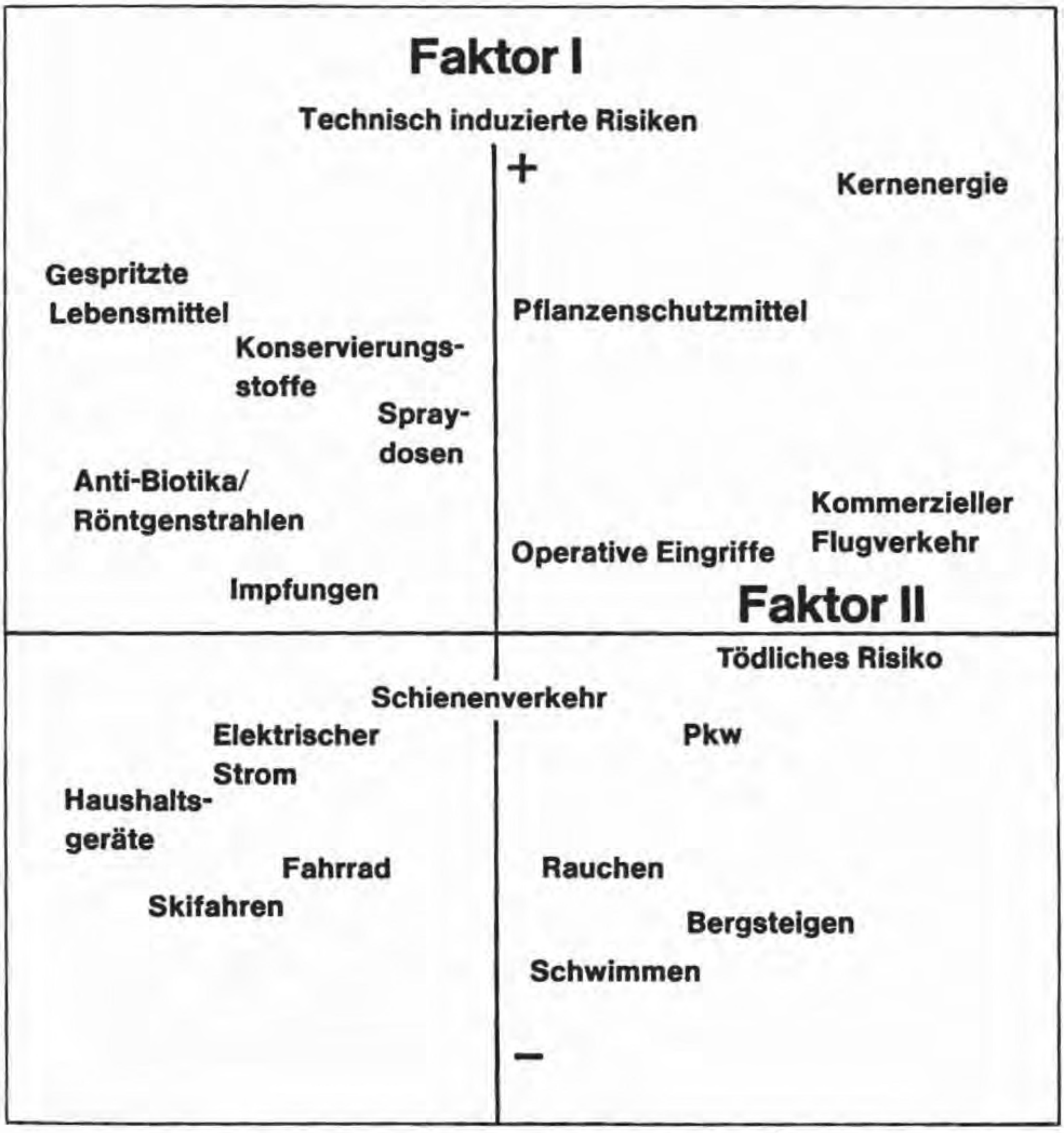
The attributive risk perception theory which has been developed in close proximity to risk theory studies is also based on object-independent structures for risk evaluation and perception. One of the first acceptance models developed in this field of research is the Dread-Voluntary Model developed by Fischhoff et al. which provides that risk acceptance - regardless of the type of risk source involved - decreases with increasing disaster potential, involuntariness and increasing certainty that the detrimental effects will be lethal (cf. Figure 2). In the meantime, these models have been refined, and an entire spectrum of influencing factors has been developed (cf. Fischhoff et al., '78, 112, p.146).

Another approach to determine the structure of risk perception and risk evaluation by individuals was adopted in the study by Maynard et al. on the disposal of radioactive waste (Maynard et al., '76, 244). The risk is subdivided into several sub-dimensions (short-term, long-term,cost, accident detection and recovery)and subsequently three independent measuring procedures are used to determine the structure of the dimensions considered optimum by the respondents. Although this model was developed exclusively for the subject in question, the authors postulate the possibility of its transfer to other risk sources. They feel that it is an advantage of this subdivision that the dimensions for the development of attitudes towards a risk source are demonstrated. And, in fact, it was shown that different combinations of dimensions are selected, for instance between environmentalists and nuclear energy experts with respect to nuclear waste disposal. While the environmentalists stated that their acceptance decision was based predominantly on the long-term risk aspects, the nuclear engineers emphasized the short-term risks (cf. Figure 3).

The structure of this risk subdivision must be considered a shortcoming of this study. While the respondents stated post factum that the decisions made appeared logical and reasonable to them, this subdivision was disproved in a preliminary test preceding our empirical study. It appears, therefore, that there is no inter-subjectively valid form of risk dimensions. Moreover, it remains an open question whether a scale listing the arguments for and against nuclear energy could not have produced the same results via a much simpler method.



Location of Risk Items in a Two-Factor
Psychological Space (acc. to Fischhoff, et al.)



Die spezifische Anordnung von Risikoquellen im Zwei-Faktoren Raum nach Fischhoff u. a.

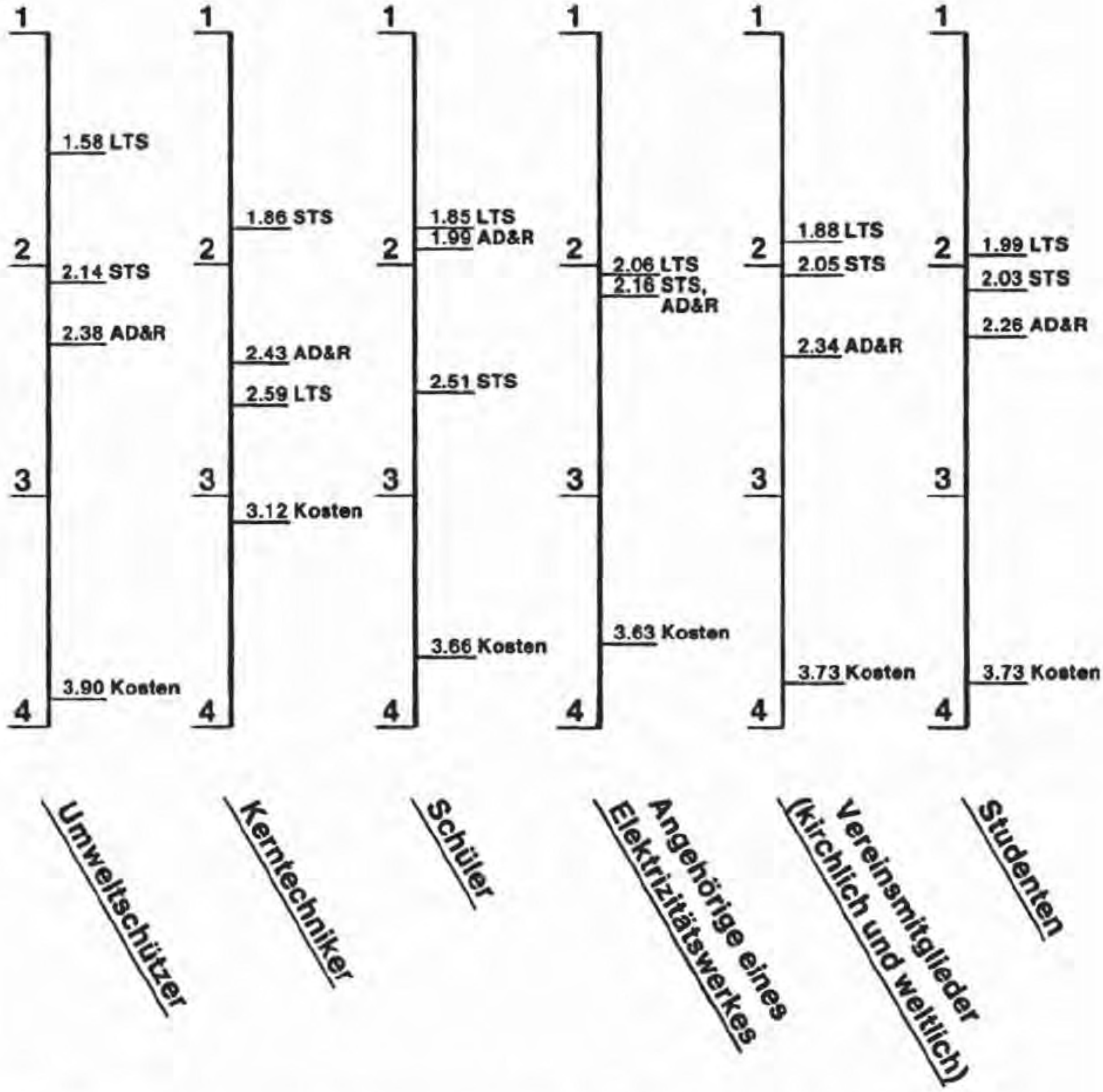
Fig. 2: Risk Acceptance as a Function of Risk Characteristics (cf. Fischhoff et al.)

Average Rankings for Six Respondent Clusters

Environmentalists	Nuclear Technologists	Jr. High and High School Students	Public Utility Employees	Church Members/ Civic Organizations	University Students
1.58 LTS	1.86 STS	1.85 LTS	2.06 LTS	1.88 LTS	1.99 LTS
2.14 STS	2.43 AD&R	1.99 AD&R	2.16 STS, AD&R	2.05 STS	2.03 STS
2.38 AD&R	2.59 LTS	2.51 STS	3.63 Cost	2.34 AD&R	2.26 AD&R
3.90 Cost	3.12 Cost	3.66 Cost		3.73 Cost	3.73 Cost

LTS — Long Term Safety
STS — Small Term Safety
AD & — Adjustment/Reduction of Risk

Mittlere Rangordnungswerte für sechs gesellschaftliche Gruppen (Risikobewertung von nuklearem Abfall)



LTS	**Betonung auf die Langzeitwirkung eines Risikos**
STS	**Betonung auf die Kurzzeitwirkung eines Risikos**
AD&R	**Betonung auf Verhütung von Risikofolgen**

Fig. 3: The Perception of Various Risk Dimensions (Risk Evaluation of Nuclear Waste)

It seems much more rewarding to use the value tree technique already described in connection with the decision analysis concepts in order to subdivide the dimensions of risk perceptions. The tree analysis permits the investigator to start out with the actual dimensional scope of each respondent group and to avoid a pre-structured risk concept which is superimposed on the subjects (cf. von Winterfeldt, '80, 333, p. 47 ff.).

The risk studies carried out by the German Battelle Institute also included a risk perception study (Frantzen, Schmid-Jörg, '76, 120). Identified perception factors included reinforcement through learning processes, dissonance reduction, conformity and nonconformity, types of cognitive reinforcement (rewards, coercive, legitimative, referent, expert power) and conflict management on the basis of game theory. With respect to nuclear energy, three influence levels are considered to be of central significance: overt anxiety (concrete and diffuse), environmental awareness and attitudes towards potential alternatives.

The second major field of psychological research is concerned with attitude formation. The most interesting approach from the point of view of methodology is that developed by Otway and Fishbein under the auspices of the IAEA/IIASA Risk Assessment Group (IAEA = International Atomic Energy Agency, a UN agency based in Vienna which also maintains a risk perception research group; IIASA = International Institute for Applied Systems Analysis in Laxenburg, Austria), since it starts out directly from the descriptive risk concept (Otway, Fishbein, '76, 302; Bowmann, Fishbein et al., '78, 41; Thomas et al., '79, 420; Thomas et al., '79, 421; Niehaus, '77, 276, p.454 ff.).

The object-independent evaluation matrices used to weight statements on a risk source are measured independently via an evaluation scale (items such as "Affluence is good" are evaluated on the basis of a good - poor continuum), and subsequently the cognitive content inherent in this evaluation is referred to the risk object and measured by means of a belief scale (nuclear energy creates affluence). The probability of correctness stated by each individual is measured separately for each statement. Once the evaluations and beliefs have been determined, the product of both components will yield the weighted cognitions on a certain risk object (Otway, Fishbein, '76, 302, pp.2 - 8). Factor analysis can be used to reduce these cognitions to a few effective parameters (salient beliefs) which determine the attitude: when this measurement technique was applied to attitudes toward nuclear energy, four different risk factors developed: environmental risks, psychological risks, socio-political risks and economic-technical benefits. As in any factor analysis, this labelling system is, of course, arbitrary. The selection of generic terms is not very convincing, especially in this field, because general risk statements are classified under psychological aspects while the concrete dangers derived from them are classified under socio-political or environmental aspects (cf. also the criticism of von der Ohe, '79, 288, p.12). Opponents and advocates of nuclear energy differ especially in that the advocates primarily emphasize the economic-technical benefits while the opponents place maximum emphasis on psychological and socio-political risks (cf. Figure 4) (Thomas et al., '79, 421, p.8 ff.).

In spite of some methodological reservations on Fishbein's model for attitude measurement, these studies have been used as prototypes for our own empirical investigations.

Beliefs about Five Energy Sources Held by Those Pro and Con the Use of Nuclear Energy

Pro Nuclear Group

Nuclear **Solar** **Hydro** **Coal** **Oil**

Con Nuclear Group

Indirect Risk

Economic Benefit

Environmental Risk

Psychological and Physical Risk

Technology Development

Vorstellungen über fünf Energiesysteme aufgeteilt nach Gegnern und Befürwortern der Kernenergie

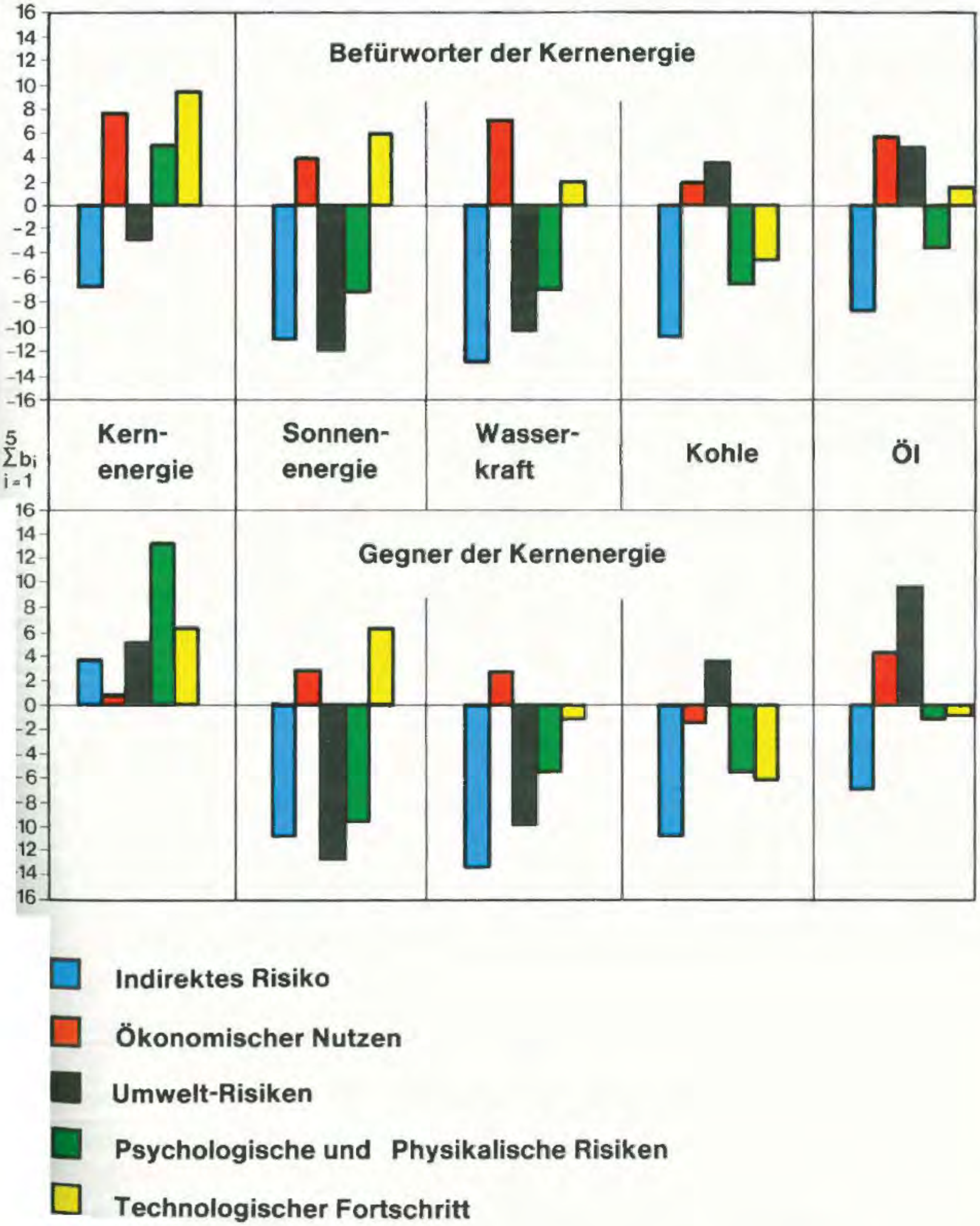


Fig. 4: Attitude Dimensions According to the Fishbein Model (IAEA Risk Assessment Group)

In addition to the IAEA studies, a number of other attitude studies have been carried out where the existence of attitudes was stipulated and correlations with external variables were sought. Examples include the studies by the American Battelle Institute (Melber et al. '77, 250), the studies of the Institute for Behavioural Research in Canada (Davies, '76, 68; Greer-Wootten, Mitson, '76, 141), two studies by Goerke (Goerke, '75, 331; Goerke, '78, 132) and an earlier study by this author (Renn, '77, 331).

A number of other studies deserve to be mentioned because they do not fit into the two classification characteristics of acceptance models and attitudes. These include the study by C. Krebsbach and G. Eisenhart (Battelle 400/3, '78, 99) on communication processes between politicians, experts and the public, a study by Gutmann on risk socialization (Gutmann, Battelle 401, '77, 147) and, finally, a methodological study by Zebroski on balance sheets in risk-benefit perceptions (Zebroski, '75, 467).

These three studies shall not be discussed in detail because they are not particularly related to the present study.

Sociological Concepts

Studies determined predominantly by sociological questions and thought processes are distinguished primarily by their scientific theory approach and their concept of society. The closer the proximity to the macro level of society, the more important the personal positions of the analysts become, so that the results are hardly comparable. Therefore, it is merely possible to summarize a few general, basic lines on the different argument levels.

One study which starts out from the microstructure of expert attitudes and from that basis attempts to analyze the conflict as a crisis in science perception, is the summary published by Helga Nowotny on her activities as scientific advisor to the Nuclear Energy Referendum in Austria (Nowotny, '79, 282). Helga Nowotny explicitly questioned the experts selected for the dialogue with the public and, at the same time, analyzed the public discussions and hearings conducted with these experts. This publication is too voluminous to allow a brief summary of its results. Of special interest is the subdivision of experts into types which differ not only by the manner in which they present their arguments but also by their understanding of science and by their identification with external points of reference (such as institutions, social values, self-perception in their role as scientists).

Thus, scientific attitudes toward nuclear energy are determined not only by factual variables but also by personality and situation variables.

This finding is further supported by the studies of D. Nelkin on the role of scientific expertise in technological decisions (Nelkin, '71, 274 and '78, 275). In case studies, Nelkin analysed the structure of the arguments advanced by both proponents and opponents of nuclear energy and revealed latent trans-scientific values and issues which to a large extent determine the positions of the scientists involved.

The highly differentiated evaluation by the different expert types identified by H. Nowotny or D. Nelkin, which is further extended into biographical and behavioural characteristics, has found a counterpart, although a simple one, in a study by Zetterberg in Sweden who classified the conduct of arguments by experts as predominantly seeking instrumental rationality in the case of advocates and value rationality in the case of the opponents, to use Max Weber's terminology (Zetterberg, '78, 470, p. 23 f.). In addition, the role of the scientist and the functioning of the overall science system of which nuclear energy and nuclear research are a part have been the subject of considerations and observations reported by Tschiedel, Hülsmann and Prüß which are more concerned with the barriers and resistance to a critical understanding of science induced by the system. These studies include few approaches of significance to the present publication (Tschiedel, '77, 424, p.96 ff.; Hülsmann, '77, 176, p.112 ff.; Hülsmann, '78, 177, p.147 ff.; Prüß, '74, 320).

The macro-sociological discussion on the ranking of nuclear energy in society represents a contest between functionalistic, systems analysis, conflict theory and Marxist-neo-Marxist approaches. All of these studies start out from the basic question as to which social and society-oriented conditions have caused the nuclear conflict, and the consequences which result from this situation.

With respect to content, the sociological studies can be classified under seven theoretical aspects:

1. Social determinants of the nuclear energy protest,
2. Diffusion and innovation research,
3. Sociological aspects of technology,
4. Conflict theory,
5. Theory of the environmentalist movement,
6. Participation theories,
7. Moral and ethical aspects of nuclear energy.

1. The discussion of the social determinants of nuclear energy protest is concerned with the question as to the society-oriented conditions of the protest movements and the description of the socially active participants in this conflict.

A review limited to the most important studies yields the following classification of society-determined initiators:

- Inability to meet the requirements of society, and transfer of this stress to functional, dead objects (Tubiana, '79, 428, p.9);
- Increasing awareness of external effects of technology (Scharioth, '77, 382, p.340);
- Mystification of nature as a model for the regulatory processes of society (Dødeтlein,'78, 80);
- Environmentalism as a pseudo-religious movement (Garrison, '77, 126, p.156; Maxey, '76, 240, p.656 ff.);
- The changed role, functions and perception of science among the public (Ravetz, '79, 328, p.8);
- Negative marginal utility of major technology as a cause of social tension (Renn, '79, 333, p.165);
- Mistrust of bureaucracy and state planning authorities (Lakoff, '77, 508, p.367 ff.);
- Increasing protection of minorities against government planning power, and transfer of generally accepted humanitarian principles to technological issues (Scheuch, '74, 389, p.38);
- Increased unemployment due to rationalization measures, creating an awareness of the ambivalence of technological progress (Scharioth, '77, 383, p.342);
- Desire for more participation (Battelle II, '77, 25, p.95 ff.);
- Changing values in developed industrial societies (Paschen, '79, 307, p.28).

The above list does not claim to be complete, but it provides an idea of the broad spectrum of explanation phenomena and demonstrates that any abstract search for causes in society is practically doomed to failure since fishing for really determinant factors in a sea of potential variables becomes a lottery game when no theoretical pre-structurization has taken place.

More promising is the second approach where positions in the nuclear energy debate are referred to specific characteristics of the individuals occupying these positions. The danger of this approach is that the causes of the exhibited characteristics are related to attitudes.

American studies (such as Douglin, '76, 81) characterize active nuclear energy adversaries as follows:

- They originate from the upper middle class or from the lower classes (i.e. they have either above-average education or very little education);
- They emphasize the necessity of environmentalism;
- They are active in civil rights movements;
- They are also committed to more social justice and participation.

The personality pattern of German nuclear power adversaries is less clearly developed. While this author in 1977 was also able to identify a coalition of less informed, highly emotionally arguing individuals from the lower classes with exceptionally well informed, highly rationally arguing members of the upper classes among nuclear energy adversaries, other studies have revealed a general overrepresentation of the lower social strata (Renn, '77, 331, p.110 ff.; Battelle II, '77, 25, p.A67). More recent polls (Infratest '77, Allensbach '79) have shown that, as a rule, income correlates to positive nuclear energy attitudes while average education and low population density (rural areas) exhibit negative correlation to that attitude.

At the present state of the art, typification of positions at best appears to have succeeded to a rudimentary degree only, especially since many of the traditional classification criteria (political orientation, political party preference, social structure criteria) can explain only a minimum of the differentiation in the positions taken. Moreover, it is in any event questionable whether a description of opponents and adherents would better reveal the motives and behavioural causes. On the contrary, it appears more important to us to classify attitudes towards nuclear energy under an individual or group-specific matrix of related attitudes in order to determine the ranking of this topic in the perception structure.

Re 2. A first step towards a higher-level approach is to incorporate the specific problem of nuclear energy acceptance into the problem field of technological innovation acceptance. In particular, this approach was taken for comparative studies which attempted to develop common factors of society's perception and acceptance of different innovations (cf.for instance Mazur, '75, 246, p.58 ff.)

Innovation and diffusion research is based on a long tradition. It would exceed the scope of the present study to review the theoretical concepts involved which are particularly concerned with the developing nations (cf. Flora, '78, 108, p.19 ff. and Rogers, '63, 334, p.38 ff.). However, some theoretically postulated and empirically demonstrated circumstances shall be briefly discussed here in order to obtain possible explanation patterns of technological risk acceptance. Primary emphasis in diffusion research is on two explanation levels:

- The question as to which social and cultural factors affect the acceptance of innovations within a social system, and

- The question of which social and personal characteristics determine positions in reacting to innovation (from acceptance to refusal).

According to Rogers ('63, 334, p.124 ff.) there are primarily five variables which play a determinant role in the acceptance of innovations: the relative advantages which an innovation would yield to the recipients, the compatibility with prevailing cultural values and social ideas, the complexity of the consequences for the social system, the possibilities for reversal (divisibility) and the communicability of an innovation.
Although these variables were determined primarily in the social context of innovation research involving American farmers, and although the problems involved in the ambivalent effects of the innovation which is to be diffused were not raised at all (Katz et al., '63, 199, p.249 ff.), these five innovation-promoting parameters can still be transferred - after some re-interpretation - to the present-day situation of the acceptance of large-scale technology and nuclear energy. For this purpose, the following relationships can be used as hypotheses:

- The more uniform the distribution of benefits and risks of a risk source between individuals or groups, the sooner will relative advantages be revealed and the sooner can acceptance be expected (distributive equivalence).
- The better the innovations match the values of a social group or institution and its concepts of the future, the sooner can acceptance be expected within this social field (and, probably, the less can it be expected outside this field when the group draws social demarcation lines) (intentional value congruence).

- The better the response of innovations to the primary human environment and the more directly they meet human needs, i.e. the fewer detours there are between stating a need and the manner of satisfying it, the sooner acceptance can be expected (functional determinacy).

- The fewer the constraints to freedom of action caused by the realization of an innovation and the fewer the number of perceived factual constraints, the sooner acceptance can be expected (safeguarding the freedom of action).

- The more consistently positive or negative information is passed by different social agents to the public, the sooner positive or negative acceptance can be expected (communicative consistency).

These five hypotheses cannot be derived directly from Rogers' statements; rather, his classification was used as a matrix to find an adequate explanation for today's innovation protest. We shall come back to these hypotheses in the interpretation of the empirical results.

Less relevant than determination of social factors which inhibit or promote innovation is the study of the second sub-area of diffusion research, i.e. the innovation acceptance process, and the description of individual positions as a function of certain social or psychic characteristics. However, one trend which is contrary to the present-day situation should be mentioned: the traditional characteristics of innovation-opposed individuals such as conservatism, advanced age, retention of given social conditions (Katz et al., '63, 199, p.240 ff.; Rogers, '63, 334, p.172 ff.; Barnett, '62, 24, p.73 ff.) are practically inverted when it comes to the nuclear energy question, if one considers, for instance, the results of the Canadian survey. The same can be stated for other countries such as the Federal Republic of Germany where the image of the conservative innovation opponent is no longer typical.

Mazur has demonstrated this recourse to deeper convictions especially for the opinion leaders in the nuclear energy question (Mazur, '75, 246, p.64 ff.). In 1975, when the nuclear energy opposition was in its very beginnings, opposition in the United States was still very small in numbers and confined to the more elitist circles. Mazur used the example of water fluoridation, a problem which had been of concern to the American public in the 60's, as a direct example. Comparing the principal explanation attempts, Mazur arrived at the following conclusions:

Table 2: Comparison of Explanation Variables for the Fluoridation and Nuclear Energy Conflicts

Explanation Variable	Fluoridation	Nuclear Energy
Hazardperception (danger)	Medium	Very high
Ignorance	None	Low
Alienation	Low	(Not studied, but fairly improbable)
Integration into major social issues	Yes, but only for the middle class	Yes, for the opinion leaders
Social influence variable	Not more than usual	Only partially
Novelty of the innovation	Yes, partially	High

On the whole, the similarity of the structure for "risk perception", "ignorance" and "alienation" appears to be interesting. In earlier studies of innovation acceptance, opponents frequently exhibited a low degree of information, little reality in their ideas of the degree of hazard and a high degree of alienation. In the case of nuclear energy this applied until as late as the mid-sixties (Erskine, '63, 102, p.180 ff.; Douvan/Withey, '54, 82,p.2). Therefore, while information on the functional principles of an innovation and a preference for rational decision-making used to be sufficient for a positive attitude, today's innovation protest is based on a notion of perceived ambivalence, not in the sense of prejudice-burdened semantic reduction (Hofstätter) but in the sense of a clear perception of negative aspects. This perception of ambivalence has been revealed in surveys on technological progress conducted in both the United States (Taviss, '72, 418, p.620) and in the Federal Republic of Germany (Battelle II, '77, 25, p.A105 ff.).

The new types of encounters between man and innovation have been typified in a study by Kates and phrased as counterparts to older typifications (such as Barnett's). Kates makes a distinction between three different innovation perception types:

- The Worry Bead School: the perceived risks frequently appear greater and more hazardous than they really are. Risk assessment is a very limited tool for providing adequate information on the hazardous possibilities, it directs attention towards very improbable catastrophic results. Technological innovations should be implemented by institutional procedures and a decision should be made on the basis of experience as to the degree of their retention in the future. Existing institutional supervision is quite adequate to ensure the safety of the population.

- The Tip of the Iceberg School: the actual risk is much greater than perceived by the population and by the experts. Therefore, prior to their implementation, innovations should be studied and analyzed carefully. The preferred tools are scenarios on the most pessimistic possibilities which could be involved in the innovation.

- The Count the Bodies School: the critical boundary has been reached where new technological innovations will produce more detrimental than beneficial effects on man's quality of life. The hazards are well known and managed, but the values and expectations towards taking risks have changed. Every man must have the right to protect himself against the effects of high-risk technology. Therefore, reduction of the technological apparatus or, as a minimum, rigid decentralization are necessary (Kates, '76, 197, p. 4 ff.).

The empirical relevance of these types has been postulated by Kates, but it has not yet been proven by the data he used. However, even as a theory this typification is useful in arriving at a new differentiated notion of innovation perception.

3. Studies on the relationships between technology and society are based more on cultural philosophy and are not as easy to translate into empirical terms. Following the German tradition of contrasting culture and civilization, more conservative social researchers such as Gehlen, Freyer and Schelsky have denounced the constraints of a technological society and its attendant devaluation of ideals and the uprooting of man, but at the same time have emphasized the rationality of the technological process and the organizations developed from it (Gehlen, '57, 127, p.8 ff.; Freyer, 70, 121; Schelsky, '61, 384, p.440 ff.). Now that H. Marcuse (Marcuse, '67, 237) and E. Bloch (Bloch, '59, 37, p.783 ff.) have introduced the subject

of "materialized rule through technology", the neo-Marxist literature typifies the role of technology as a camouflage instrument of the ruling class (Bahr, '70, 21, p.67 ff.; Ullrich, '77, 434, p.165 ff.). This position holds that certain technological developments tend to preserve privileges and consolidate the existing structure of society, especially through different forms of materializing the rule. To that degree, opposition to certain innovations is part of a revolutionary restructurization process.

Although these theses contribute little to the subject of the causes for the social conflict on nuclear energy (unless information on exploitation through technology were a determining action principle of the opponents), this interpretation of the nuclear energy conflict precisely fits the observation described above that a restructurization of value orientations from promoting to inhibiting information is taking place.

Re 4. One significant component of this new value orientation is the awareness of the environment. Unlike the diffusion researchers, the theoreticians of the environmentalist movement hold that this protest movement is motivated less in terms of innovation or technology than in terms of the effects of this technology (or of any other measure) on the environment. Deeply concerned with environmental pollution, aroused by the limits of growth and full of self-doubts as to whether the consumer-orientation of our society is meaningful, new groups have formed and existing groups have changed their objectives to use their influence actively in favour of our natural environment and to protect it (McEvoy, '72, 247, p.217 ff.). The different phases of the environmentalist movement, from a more voluntary self-control all the way to major demands for participation, have been frequently described and analyzed (Means, '72, 249, p.209 ff.; Tognacci, '72, 422; Mayer-Tasch, '78, 242, p.8 ff.; Rammstedt, '77, 324, p.447 ff.).

One observation with respect to the environmentalist movement is of special interest for the question as to the acceptance of technological innovations: this is the fact that those who suffer most from environmental pollution are least involved in action or protest against it (McEvoy, '72, 247, p.226 ff.). Three theoretical concepts are advanced to explain this phenomenon:

- The inadequate reciprocation in social exchange (originally advanced by Blau, 1964; Turner, '69, 429, p. 819);
- Relative deprivation (originally advanced by Merton, Stouffer, '50; Turner, '69, 429, p.819);
- The hierarchic needs structure (originally advanced by Maslow, '54; Mauss, '75, 239, p.578).

The degree to which these three concepts can explain the fact that, of all people, individuals privileged in terms of environmental quality have the greatest perception of environmental pollution, is difficult to verify by empirical means. However, all three explanation concepts are plausible: resistance in the lower classes cannot develop due to lack of social and political resources; compared to other problems, environmental conservation is of secondary importance for these classes (while it is of primary importance to the middle class); and in this social situation the desire to meet primary needs supersedes any concern for the environment. It is likely that all three explanations represent part of the true motives. The political conflict on environmental conservation also includes the thesis that, in promoting environmental conservation, the middle classes wish to erect a barrier to inhibit the social climbers of the lower classes by strangling economic growth (Gilliam, '72, 129, p.41). However, empirical proof for this thesis is still outstanding.

In the meantime, some authors have developed normative social designs for the future embodiment of technology and society from theories on the environmentalist movement. A rich literature has developed under the headings of "soft technology" and the ideal of a "new life-style" which, recognizing a deficiency of major technology - its centralized organizational structure, its high institution cost and its social vulnerability and resilience - describes new development lines towards a more decentralized supply structure, standardization of the roles of consumer and producer and greater political participation at the local level (Traube, '78, 425; Dickson, '78, 74; Huber, '78, 175; Amery, '78, 11; Lovins, '77, 127). There is no doubt that these theories have motivated part of the anti-nuclear energy movement as utopian designs (Kitschelt, '80, 532, p.309).

Re 5. Stimulated by the environmentalist movement and the fact that many young people have started out toward new Utopias, the conflict theoreticians have developed models of their own. In these models they make a distinction between an identity crisis of industrial man induced by the ecological movement on the individual level and a politically induced legitimacy crisis on the control level of society (cf. Habermas, '79, 149, p.50 ff.; Rammstedt, '77, 323, p.40 ff.). While the identity crisis involves a rethinking process on the part of man to turn from consumption and growth orientation to an awareness of the environment, the legitimacy crisis is concerned with the inability of the political system, perceived by the population, to meet adequately a threat to our world: environmental pollution and waste of natural resources (Kielmansegg, '79, 205, p.31 ff.; C. Offe, '74, 286, p.129; H. Gripp, '78, 142, p.248 ff.). It is postulated that competitive democracy would never take harsh and incisive measures to avoid disappointing the voters and that the four or five year cycle in which the voters approve their government can no longer ensure a long-term political action perspective. Authors of neo-Marxist or Marxist orientation feel that the environmental problems are an expression of the capitalistic production crisis which continues to aggravate due to the insurmountable conflict between profit management and quality of life (Pickshaus, '75, 315, p.71 ff.; Bernt, '74, 30, p.40 f.).

More closely integrated with the technological innovation problem is Lübbe's thesis that the protest against technologies compensates for the oppressive experience of diminishing cultural confidence (Lübbe, '79, 230, p.3). He feels that an increasing marginal utility experience with respect to technology has led to the erroneous interpretation that the crisis is a value reflection crisis while, in reality, it is a management crisis since it is not the society targets generally associated with technology which are under dispute but the value-means relations and the alternative approaches which can be used to achieve these targets (Lübbe, '79, 230, pp. 10, 15).

Similar arguments are used by Scheuch who feels that the protests against technology can also be understood as a reduction of technological complexity via moralization, a means used especially by the cultural elite which is favoured as a reference group, in order to be able to discuss anything and, at the same time, become immune to actual attacks (Scheuch, '74, 389, p.38). It seems to us that the crisis theories, although often excessively burdened with ideologies, represent quite meaningful approaches towards a macro-sociological theory of the protest movement.

Re 6. The participation concepts remain to be discussed. In this field it would be presumptious to present a summary review of the entire literature. With respect to the nuclear energy conflict, participation research centres on two major questions:

- How can the democratic, institutionalized and representative political structures be reconciled with the new demands and campaigns for more political participation, and what types of conflict resolution models can be identified? (Zilleßen, '78, 472; Nelkin, '78, 275; Guggenberger, '78, 146, p. 172 ff.).

- How can the various interests of society which are neglected by the social and political exchange system be so predicted and organized that approximation to a normative-democratic structure can be achieved? (Paschen, '78, 307, p.34 ff.; Battelle II, '77, 25, p.B29 ff.; Wüstenhagen, '76, 462, p.13 ff.)

Both questions reveal the basic attitude in the evaluation of the nuclear conflict: the risks of nuclear energy cause disadvantages - in reality or in the perception of the affected individuals - to certain groups which defend themselves and, in the process, incorporate potentially affected individuals and other disadvantaged groups (Turner, '69, 492, p.826). The political system is forced to react since it has to operate on a broader base due to party coalitions. Up to this point the analyses of most authors are identical. Subsequently, however, opinions differ: conservative theoreticians fear that adoption of the participation demands would result in the adoption of particularist interests and an institutionalization of parochial politics (von Unruh, '74, 435, p.74); systems analysis theoreticians either doubt the capability of the political system to perceive the adopted demands as they relate to a commitment to reduce complexity (Luhmann, '72, 231, p.156 f.), or they feel that it is only the adoption of these participation demands which can guarantee an acceptable reduction (Battelle II, Part B, '77, 25, p.B31; Gripp, '78, 142, p.283 f.). Advocates of a normative theory of democracy or a pragmatic political approach, are in favour of the introduction of new types of participation and have designed the appropriate models (Dienel, '77, 75; Zillessen, '78, 474, p.122 ff.). In addition to the theoretical debate on participation, objectives and structure of citizens' action groups, especially in the German-speaking countries, are studied empirically, and their relevance to present-day politics is investigated (Andritzky, Wahl-Terlinden, '78, 13; Kodolitsch, '75, 210, p.264 ff.; Kempf, '78, 201, p.358 ff.).

Although participation and nuclear energy are closely related, the problems and topics arising in this field cannot be generally tranferred to risk acceptance and technological innovation. However, acceptance problems can initiate the desire for participation and may lend one of its components, such as nuclear energy, a symbolic character for the entire movement. And yet, participation research has hardly ever clarified the step from a diffuse innovation protest to an organized movement of symbolic character. At best there is the useful note that it is not the distorted perceptions or symbolic reductions (refer to the criticism of the psychological approach) which initiate the conflict, but genuine disadvantages and shifts of interest.

Re 7. We should like to forgo a more detailed discussion of the ethical value analyses of the nuclear energy conflict which originate either from a normative attitude towards democracy or from a transfer of institution-specific value matrices to the conflict (by the churches, for instance). These studies are in most cases not relevant for a description of the scientific analysis of the nuclear energy protest.

It is hardly possible to write a transparent critical analysis of the sociological literature on nuclear energy, especially not in the concise form required here. Some significant items of criticism have already been mentioned in the description of the concept. Review of the different sociological research concepts appears to allow the following conclusions:

- Modern diffusion research, which incorporates determinant research on nuclear energy attitudes and research into influencing social factors, is potentially able to lead to better clarification of attitude formation and of the acceptance process;

- The analysis of the environmentalist movement can describe and analyze the origins and development of movements, the value adjustments on which they are based and the specific problems of involvement representation;

- Conflict theories afford a suitable framework of explanations for macro-sociological stimuli which have short-term effects on society. The multiple-level application of the crisis concept to individuals, groups and society as a whole also makes this theory useful as an integrative explanation matrix, although the restrictions of the theoretical environment (crises presuppose abrupt disturbances) allow only partial application.

- Participation theories shift the basic question of acceptance and perception towards the level of decision-making power on the imminent realization of innovations. Combined with this is the idea that conflicting interests are the decisive causes of innovation protest which, as a rule, can be bridged and resolved only through normative democratic mechanisms or restructuring of society.

Open Questions and Phenomena Requiring Explanation

The difficulties of studying nuclear energy problems with the tools available to the social sciences are the topicality and the dynamics of the conflict which make simple, static decisions quite useless, and the fact that ideologies already dominate the positions. The demand for a theoretically well-founded and empirically justifiable research concept results in the necessity of clearly developing the phenomena requiring explanation and identifying that area which we intend to analyze thoroughly. If we review once again the results and theories of acceptance research presented in this chapter we must arrive at the conclusion that the following problems have not yet been satisfactorily resolved:

- The types and structures of the decision-making process in the face of risk-burdened circumstances, and the types of risk perception;
- The weighting and evaluation of perceived risk components and their combination into an acceptance decision;
- The social and personal factors which have positive or negative effects on such an acceptance decision;
- The formation of attitudes towards nuclear energy and its connections to other external objects as well as to psychological and social determinants;

- The stress situation in the populace caused by intuitive risk perception and anxiety on the one hand, and loyalty to reference groups and confidence in the institutions of society on the other hand;
- The opinion-forming process on risk problems by relevant social groups, in particular the discrepancy existing between the attitude of the leadership and that of the group members which can already be observed (for instance in the political parties);
- The effect of organized protest groups and non-organized protesters on public opinion and the formation of political beliefs;
- The increasing loss of confidence in political planning authorities and in the experts who support them, and the loss of legitimacy in the acceptance of political decisions;
- Political and social developments as well as institutional barriers for a reorientation of the value system of society toward alternative objectives in life.

It would be presumptuous to attempt discussion of all of these problem aspects and corresponding theoretical concepts within the scope of just one study without taking recourse to trivial or superficial explanation patterns. Therefore, a selection from the great variety of problem items is required; at least under the present state of the art a comprehensive review, as desirable as it may be, is still impossible. In order to achieve progress toward this objective over time, it appears to me a priority task to discuss in particular the basic structures of the present-day conflict, since it is only the knowledge of this structure which allows an approach toward the developments and endeavours of society which are based on it. While the latter certainly follow their own laws, they are easily misinterpreted in the absence of information of the basic motives which initiate them. In our view, the following three problem areas are of basic significance for the present-day nuclear energy conflict:

- Risk perception and its intuitive evaluation;
- Formation and structure of attitudes towards nuclear energy;
- Psychic and social influence patterns which explain these attitudes.

These aspects, which still appear abstract here, will be filled with more life and content in the next section devoted to the development of the conceptual tools.

Part II

Risk and Risk Perception

Basic Theoretical Concept

Definitions

The risk concept is one of the major topics in the analysis of the conflicts involving modern technologies. This does not merely concern the problem of the factual quantifiability of risk consequences but also the perception and weighting of these consequences by the public. A more detailed analysis of these two complexes requires clarification of the terms risk, risk perception and risk acceptance. For this purpose, some definitions and the associated explanations shall be given.

Risk shall be defined as the probability of negative or positive consequences which result from the realization of an event or course of action.

Risk perception shall be defined as the mental representation and memorization of the negative or positive consequences of a risk source and the probability of their occurrence by individuals, groups of institutions.

Risk acceptance shall be defined as the result of a decision-making process on risk sources which is significantly affected by a combination of subjectively weighted and evaluated consequences and their subjective probabilities.

Risk Concept

Risk has been defined as the probability (1) of negative or positive consequences (2) which result from the realization of an event or a course of action(3). These three components require some explanation:

(1) The term probability is difficult to define since it may have different meanings in different contexts. A major distinction can be made between three definitions of probability:

- The logical concept which holds that probability represents the degree of certainty by which an event can be classified as being true;
- The distributional concept which holds that probability represents the relative frequency of an event over time;
- The personalistic concept which states that probability represents the strength of a conviction that a certain event will in fact occur (Lee, '71, 509; Sjøberg, '77, 522, p.6 ff.).

The third, personalistic definition is irrelevant for risk definition as an objective quantity. However, the logical and distributional definitions must be combined since it is necessary, on the one hand, to specify the probability for the accuracy of a statistical conclusion and, on the other hand, to state the expected value (including the statistical confidence interval) for the event under consideration. For instance, a correct statement taking into consideration both of these criteria would read approximately as follows: As a consequence of risk source X, 30 to 35 persons per annum will die with a certainty of 95%.

Unlike other risk definitions, the present study does not merely relate risk to the probable consequences but also to the certain consequences. While this is contrary to the intuitive risk concept (Rowe, '77, 349, p.25), it is significant for further analysis because the certain detriments and probable detriments are not independent of each other.

(2) Unlike general usage it is proposed to consider positive and negative consequences - as implied by the economic risk concept - and not merely the probability of detrimental consequences since the degree of risk (not merely of risk evaluation) is highly dependent on the potential benefits. Consequently, benefits and detriments are never independent of each other. The terminology should allow for this fact.

The type of risk consequences is also significant. Any risk source first of all meets a <u>direct</u> purpose such as energy availability, covenience or income, and causes cost in terms of time or money. In addition to these direct parameters, <u>indirect</u> consequences occur such as health detriments, death, restrictions to freedoms or better quality of life, more consumer potential, reduction of natural risks, more occupational opportunities.

Direct and indirect consequences can be determined in real terms, i.e. in terms of substantial changes which may also be taking place in society or in politics. In addition, there are two more types of consequences: <u>intangible</u> and <u>symbolic</u> consequences. Intangible consequences are defined as evaluation patterns applied to overt characteristics of the risk object which are subjectively variable (such as æsthetic degradation of a landscape). For the purposes of this study, symbolic consequences shall be defined as consequences attributed not to the characteristics of the objects themselves but to projected extraneous attributes. As an example we could name the benefit perceived by adolescents when they smoke, in that they perceive themselves to be adults sooner than other adolescents (a usefulness which is not concerned with the cigarette itself, but with its symbolic value to adolescents), or the nationalistic pride involved in the construction of nuclear power stations.

(3) The causes for potentially negative or positive consequences arise from the realization of events or actions. Consequently, it is significant that consequences can be traced back to concrete objects or actions, or can be anticipated; diffuse anxieties or concerns should be explicitly excluded. The connection to an initiating event or action must be clearly established in order to satisfy this part of the definition.

However, for the existence of a risk it is not necessary that the protagonist knows this connection or has deliberately caused the hazardous conditions.

Risk Perception Concept

Risk perception has been defined as the mental representation and memorization (1) of negative or positive consequences (2) and of the probability of their occurrence (3) by individuals, groups or institutions (4).

(1) In this definition, perception is analytically separated from the weighting of the content items, although there is no doubt that these have a feedback effect on the selection of certain conditions and the attention devoted to them. Many types of subjective perception exist. An attempt at a rough classification will yield the following in summary form:

- Perception of risk dimensions and calculation of their probability based on the individual's own experience (observational perception);
- Perception of risk dimensions and calculation of their probability on the basis of publically documented experience (documentary perception);

- Perception of risk dimensions and calculation of their probability on the basis of exchange of experience (communicative perception);
- Perception of risk dimensions and calculation of their probability via association chains (associative perception);
- Calculation of probability and uncertainty dimensions via subjective assimilation mechanisms (intuitive perception).

Consequently, perception by laymen and by scientists differs merely in the degree of application of the different perception modes. Thus, scientific risk analysis can only utilize that personal experience which is reproducible, or it can only employ that calculation which is acceptable within the framework of formal logic and scientific conventions.

In addition to the perception of circumstances, memorization of the perceived circumstances is a second constituent criterion of risk perception.

(2) In the perception of a risk, positive and negative consequences are again included as risk consequences, but again this includes only the perception of these consequences, not their evaluation. At first glance it appears audacious that this definition includes only two variables of risk perception: consequences and their probability. Considering the great variety of factors which have been established as constituent perception criteria in decision-making theory experiments (distribution variance, distribution semi-variance, internalized risk threshold values, qualitative risk criteria etc.), this limitation to the classical components of consequences and probability does not appear justified. On the other hand, however,

these third-level and fourth-level factors as a rule determine the evaluation of a risk, not its perception, and, moreover, they can be interpreted as subjectively perceived consequences of a risk source. Thus, voluntary risk acceptance, which is defined as a qualitative characteristic, can be considered to be a conclusion drawn from the structure of certain risky circumstances, stated approximately as follows: if the detrimental effects do occur, I will not have any influence on the dimensions of these effects and will be dependent on the assistance of other people.

(3) Unlike the case of risk definition, probability in the context of perception is understood to be a personalistic parameter, meaning that, similar to the risk consequences, the calculation is based on the subjective yardstick used in each case. It is not the strength of the belief that a certain event will occur which is considered to be the operational definition but the subjective notion of relative frequencies. While this limitation of the probability concept simplifies the complex semantic scope of subjective probability, it represents the only meaningful possibility for measuring the same dimension of probability each time when considering different individuals.

(4) Individuals, groups and institutions are named as risk perception agents. Experiments on the "Risky Shift" phenomenon have demonstrated that group-specific types of risk perception exist. Individuals in a group state a greater risk acceptance than they do in individual decisions (Stoner, '61, 524). However, the exact opposite, a so-called "Cautious Shift", can also occur (Stallen, '77, 523, p.6). Both shift types can be considered to be elements of a group-dynamic process tending toward polarization. Institutions,

too,will arrive at other forms of risk perception than the individuals working in them, based on their objectives and value system. Therefore, an analytical distinction between individuals, groups and institutions appears justified.

Risk Acceptance Concept

At the outset of this chapter, risk acceptance was defined as follows:

Risk acceptance shall be defined as the result of a decision-making process (1) which is significantly (2) affected by a combination of subjectively weighted and evaluated consequences and their objective probabilities (3).

Again, a brief explanation of the definition components shall be presented:

(1) Risk acceptance is not defined as a behavioural pattern but as a result of a reasoning process of weighing between subjectively weighted benefit and risk consequences. Precisely speaking, acceptance includes five steps:
- Collection of risk information,
- Allocation of subjective probabilities to these information items,
- Weighting of these cognitive elements,
- Comparison of the weighted elements,
- Comparison of the results to potential alternatives and to non-use of the risk source.

Consequently, it is assumed that individuals in some manner process the multi-dimensional positive and negative elements to obtain a total weighting which allows comparison to other risk sources. And this appears intuitively plausible since every individual is forced in everyday life to select from several hazardous alternatives, one alternative which is optimum for that individual. It is immaterial whether the best option in the sense of normative optimization is actually selected. The only important aspect is that, in the final analysis, comparison between risk sources can only take place when the individual has found a yardstick for comparison which is valid for risk sources.

However, the reduction of perceptual elements to an acceptance decision must not be equated with the existence of a standard yardstick for all types of risks.

Risk yardsticks are referred to the subjectively perceived common features of the risks to be compared, and all the available empirical research has shown that a universal risk evaluation pattern (such as a product of losses and probabilities) is not likely to exist. In spite of this limitation, it is meaningful to retain the artificial concept of risk acceptance as a generic term. In the case of different classes of hazardous actions or events, a selection will certainly not always take place according to the same criteria; however, similarities in the strategies of the approach, in the pattern used for allocating information and in the specific weighting mechanisms might also exist in the case of heterogeneous risk decisions.

(2) It is not intended to claim that acceptance is exclusively determined by the weighted cognitions of the risk source. However, it appears meaningful to postulate that the greatest part of the variance of an acceptance decision can be explained by the latter. This assumption is in keeping with the notion that man decides predominantly on an object-rational basis,

i.e. after weighing subjectively recognized advantages and disadvantages,and that effects alien to the object (such as perceived or subconscious anxieties) play a role in this process but do not determine the result of the decision-making process. This view of the decision-making process which is primarily advocated by Janis and Mann (Janis, Mann, '77, 499, p.95 ff.) is frequently contradicted by studies based on depth psychology (such as Wünschmann,'80, 460). The empirical results rather tend to be in favour of the thesis of an object-related decision-making process since it has been possible, as a rule, to explain the major portion of the decision's variance with the aid of statement scales and weighting factors (Fischhoff et al., '78, 116; Thomas et al., '79, 421).

(3) The acceptance process requires a combination of the perceived elements before a decision can be made at all. The manner of calculating this combination, whether by eliminating insignificant elements, summation of all elements, or other types of summarizing, will be disregarded for the generally applicable definition. Views on this subject have differed greatly until today and it is also doubtful that all risk sources are summarized by means of identical patterns.

The most important step between risk perception and acceptance is the process of weighting and evaluating the cognitive elements on the basis of personal value estimation factors. In this process, the perceived consequences, the subjective probabilities and their combination can be attributed weights of their own. Again, the type of combination will be disregarded here. A review of the evaluation levels postulated in the literature will yield a distinction between five different classes of factors:

Congruent Case:	**Equal Distribution of Risk and Benefit**
Altruistic Case:	**All Share the Benefit, Few Take the Risk**
Oligocentric Case:	**Few Share the Benefit, All Take the Risk**
Inaequivalent Case:	**Few Share Risk and Benefit, Most Have Only the Risk or the Benefit**
Disjoint Case:	**The Ones Take the Risk, the Others Have the Benefits**

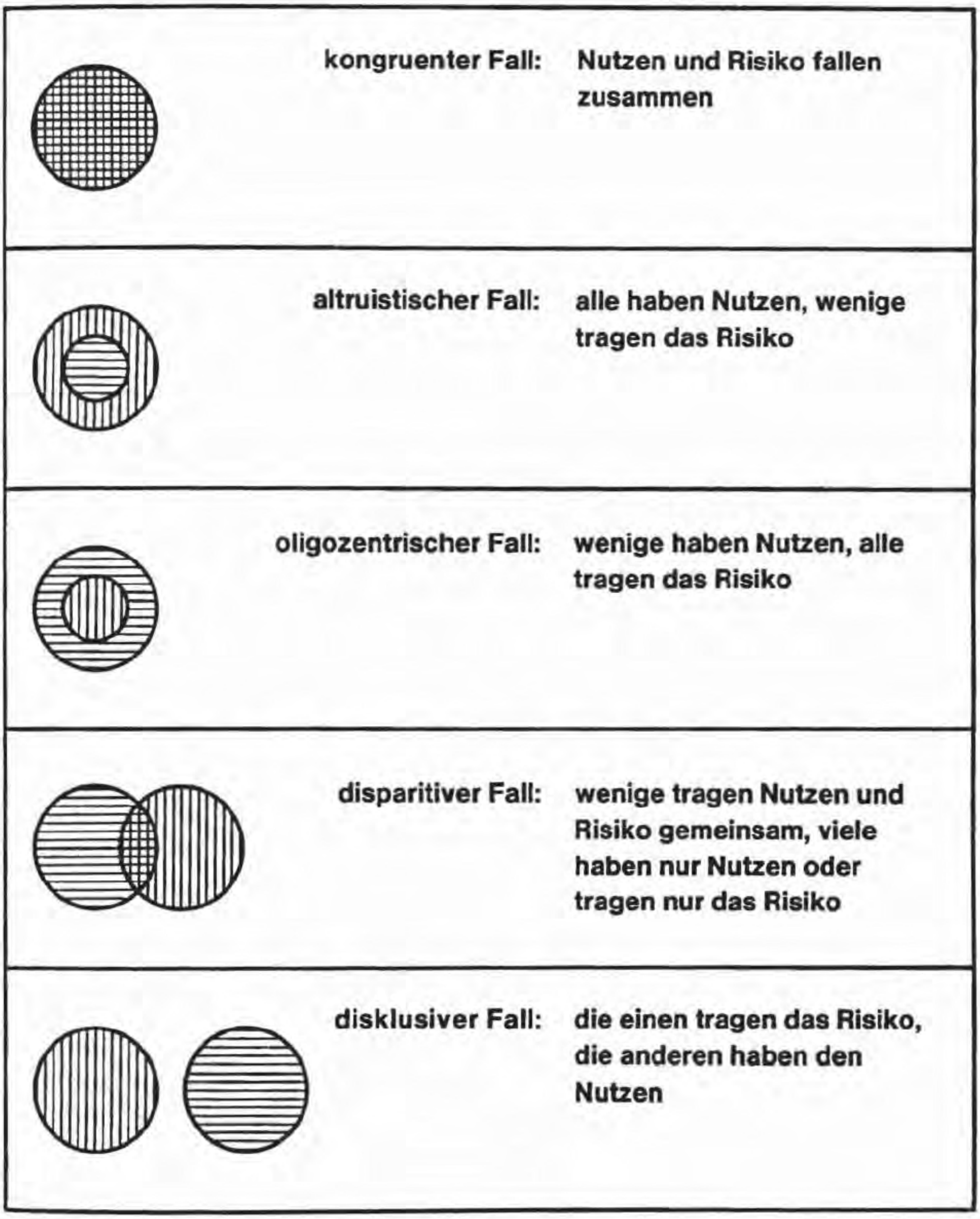


Fig. 5: Types of Risk-Benefit Distribution

a. Distribution of benefits and detriments between the individual, the individual's reference group and society as a whole. According to the graph below (cf. Figure 5), a distinction can be made between five basic distribution types:

- The congruent case:
  Equal distribution of risk and benefit for a person or a group.
- The altruistic case:
  All have benefits, but only a few have detriments.
- The oligocentric case:
  Few have benefits, but all have detriments.
- The inequivalent case:
  A few share the benefits and detriments, while others have only benefits and/or only detriments.
- The disjoint case:
  One group bears all the detriments while the other group has all the benefits.

The question as to the distribution of benefits and detriments not only arises anew for each risk source, but also for each type of risk element* (direct, indirect, intangible or symbolic consequences). From the great variety of possible combinations, four special cases shall be developed here which have special weight in view of the present-day conflict:

- Relatively uniform distribution of direct benefits and detriments, combined with a low degree of external effects. This case is least problematic and is usually accepted (for instance, in the case of consumer products).

- Relatively uniform distribution of direct benefits and direct detriments, but greater disparity of the indirect consequences, or broad distribution of indirect benefits but not of the detrimental effects. In this case, a conflict between the rationality of the planning authorities as an element of society and the individual rationality of the persons accepting the risk will result (for instance, in the case of major technological facilities producing a public or semi-public good such as electric power).

- Relatively uniform distribution of direct benefits and direct detriments, one group has the indirect benefits while the indirect detriments are distributed. This situation will result in conflict between the groups of a society (for instance, when industries are established in a location where great benefits are granted through tax advantages and creation of new jobs, while the detriments such as a waste air cloud have the greatest effect in neighbouring towns).

- Imbalance of direct detriments and direct benefits. This case requires a socially or ethically motivated acceptance on the part of the disadvantaged, i.e. a transfer legitimation, because otherwise open conflict can be expected (example: open prison).

Typification of risk sources on the basis of their distribution structure is neither exhaustive nor complete. The literature hardly yields any approach towards a theoretical penetration of risk distribution; empirical studies are entirely non-existent (Rowe, '77, 349, p.129 ff.; Lowrance, '76, 128, p.94 ff.; Wagner, '78, 443, p.3 ff.).

b. Inherent characteristics of risk source and risk consequences (qualitative risk characteristics).

Unlike distribution effects, the so-called qualitative risk characteristics have been more frequently the subject of studies. The Table below (cf. Table 3) provides a review of most characteristics which have been identified so far.

Table 3: Qualitative Risk Characteristics

1. Factors Concerning the Type of Risk Consequence:
   - Voluntary exposure
   - Risk avoidance possibility
   - Discounting in time
   - Spatial distribution
   - Identifiable or anonymous risk taker
   - Personal control over the outcome
   - Supervision by society
   - Perceived degree of control
   - Degree of familiarity
   - Degree of scientific and technological maturity
   - Habituation

2. Factors Concerning the Order of Magnitude of the Risk Consequence:
   - Fatal versus limited damage
   - Delayed versus immediate effects of damage
   - Catastrophic versus chronic damage
   - Extreme cases of the ratio of the magnitude of consequences and their probabilities

(continued)

Table 3 (continued)

3. Factors Concerning the Nature of the Risk Source:
   - Human, social and artificial risk sources
   - Individual avoidability of potential hazards
   - Possible perception with sensory organs
   - Reversibility or irreversibility of the potential damage
   - Existence of alternatives
   - Distance from the risk source

4. Factors Specifically Referred to Benefits:
   - Exclusivity of benefit experience
   - Public versus private good
   - Uniform distribution of benefits

(Rowe, '77, 349, p.42; Otway, '77, 297, p.4; Otway et al., '75, 296, p.3 ff.; Døderlein, '78, 80, p.17 ff.; Starr, '77, 409, p.446 ff.; Slovic et al., '79, 872, p.11 ff.; Swaton et al., '76, 379; Maderthaner et al., '76, 236, p.5 ff.; Vlek, Stallen, '79, 529, p.19 f.).

Empirical studies have confirmed that voluntariness, familiarity and the severity of damage have a special effect on risk acceptance (Fischhoff et al., '78, 112, p. 144 ff.). In addition, personal monitoring possibilities, habituation effects and avoidability have been identified as significant effective parameters (Swaton et al., '76, 379, p. 7 ff.; Maderthaner et al., '76, 236, p. 6 ff.; Peters, '79, 314, p. 96 ff.). However, none of these studies reveal the significance of the qualitative risk characteristics for risk acceptance or their general applicability to different types of risk.

c. Attributive, possibly universal erroneous interpretation patterns of individuals (attributive biases).
These sources of perception and weighting were already identified in our description of the decision-making theory and risk analysis studies. The overestimation of risk sources with dramatic effects, the underestimation of the probabilities in a catastrophic risk consequence, the perception of one's own experience as a reliable yardstick and the negative relationship existing between the complexity of a risk source and its intuitive acceptance are only a few of the mechanisms used to assimilate information on risk sources under the "common sense" concept. The primary question is to determine how individuals transfer risk to their own lives and develop notions on damage possibilities and probabilities; the other question involves the generalization process where an awareness of exposure, once developed, is expanded to include general circumstances. The first area has been represented as "availability" in the mostly English-language literature, and the second as "representativeness" or "intuitive regression" (Stallen, '77, 523, p.7 ff.; Slovic et al., '79, 371, p.15 ff.; Tversky/Kahneman, '75, 432).

The topic can be summarized by stating that memory, the capability to imagine consequences, perceived publicity and dramatic effects of the potential damage have an effect on the strength of the potential exposure variable, and that the extrapolation from small numbers to an entity, the neglect of statistical dispersion and the overestimation of redundant information determine the type of intuitive generalization (Ross, '77, p.173 ff.; Bierbrauer, '77, 34, p.71 ff.).

d. Situational effects and dispositional characteristics of the weighing medium (subject-referred criteria).
There is no doubt that situational and dispositional factors explain a considerable proportion of the acceptance of risk sources. The majority of attitude research in this field has the objective of determining via correlation analysis the dependencies of attitudes towards external variables such as psychic factors, situational characteristics or social structures. However, the value of these external variables for weighting the risk elements has remained a matter of dispute until today (Kogan, Wallach, '72, 504, p.137). Apparently there are quite a number of subject-referred weighting factors which could have an effect on the evaluation of the cognitions:
- Related and similar attitude systems,
- Internalized value structures,
- Psychic characteristics,
- Social structural characteristics,
- Desire for consonance with reference groups,
- Individual role and external role attribution in the interaction with risk informants.

Probabilistic Risk Analysis for Technologies

After defining the most important terminology of the risk concept it is indispensable for the further theoretical approach to deal with the problem of the objective quantifiability of risks. On the one hand, this involves the problem as to how far a comparison of so-called objective risk analyses and subjective perceptions is acceptable at all and, on the other hand, the question as to the information value of probabilistic risk analyses for risk research in the social sciences. Both problem areas are directly concerned with the selection of a theoretical frame of reference and its empirical transformation. For instance, is it acceptable to measure distorted risk perception if there is no certainty that the objective reference parameters are correct? Is this a question of a communication deficit or is it the consequence of the inadequacy of objective risk studies that probabilistic risk analyses (such as the one suggested by Rasmussen) have no far-reaching consequences on public attitudes?

Scientifically substantiated analyses on the consequences of risks attempt to identify the consequences of the perceived event (or its perturbations) and to calculate their probabilities.

Without doubt, the calculation of these two quantities is never complete or unambiguous and, at the same time, it is not free of subjective judgements or scientific conventions. Some arguments shall be presented in support of this statement:

- Estimation and identification of risk consequences has so far been possible only for direct damage to human health and to the environment, while other consequences (such as intangible or symbolic consequences) are difficult or even impossible to handle by numeric analysis.

- Any identification of consequences must, of necessity, consist of a selection from the unlimited number of possible error profiles. In spite of systematic and highly differentiated model computation (such as error tree analysis) it is impossible to predict all possible damage events, far less the damage consequences.

- In addition to the limited nature of the analysis of nuclear accident events and potential consequences, it is absolutely necessary to limit the exposure paths so as to avoid endless speculation. For each damage event, second-order and third-order consequences (cf. Figure 6) are conceivable which result as consequences of the next-higher order. Since the number of potential consequences rises exponentially with each additional order level, a convention is required with respect to the link in this chain where the border line of analysis is to be drawn.

- The evaluation of orders of magnitude for consequences must be based on a substitutive relationship of risk consequences. This applies not only to the cost-efficiency analysis often discussed in the literature where an optimum trade-off between cost and safety must be determined (cf. Figure 7), but also to any type of indirect consequence (such as the degree of security of facilities against sabotage versus the acceptable limitations to the freedom of the staff employed in that facility). An optimum point in the relationship between risk consequences can be established only subjectively or only on the basis of a scientific convention since a generally applicable optimization rule and a generally applicable yardstick of comparison for all risk consequences cannot be determined intersubjectively.

- In the computation of probabilities the problem arises of determining the statistical confidence intervals for the occurrence of accidents and possible consequences since the statistical axioms of random distribution, independence of measured data and constancy of third variables are satisfied to an inadequate degree only (for instance, by a transfer of experience acquired on technical systems in a conventional facility to hypothetical computations of failures in a different technological context).

System: Event		Possible Pathways	Exposure to Recipient	Pathways of Second Order	Exposures of Second Order
				Pathway 1.1	Exposure 1.1
			Exposure1	Pathway 1.2	Exposure 1.2
		Pathway 1		Pathway 1.3	Exposure 1.3
				Pathway 2.1	Exposure 2.1
Risk-Objekt	Technical Damage	Pathway 2	Exposure 2	Pathway 2.2	Exposure 2.2
		Pathway 3		Pathway 3.1	Exposure 3.1
			Exposure 3	Pathway 3.2	Exposure 3.2
				Pathway 3.3	Exposure 3.3

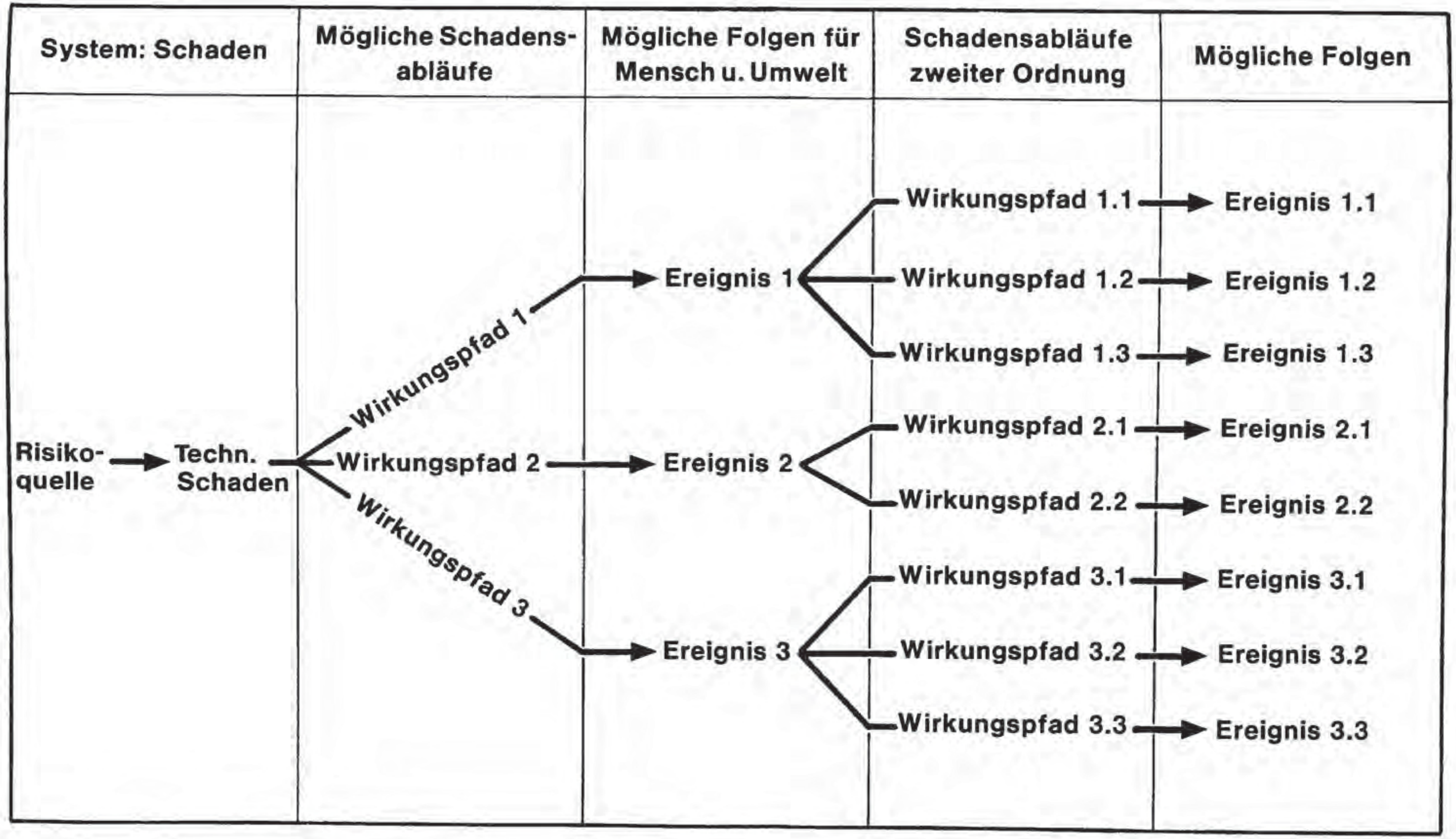


Fig. 6: Outcome-Exposure Pathways

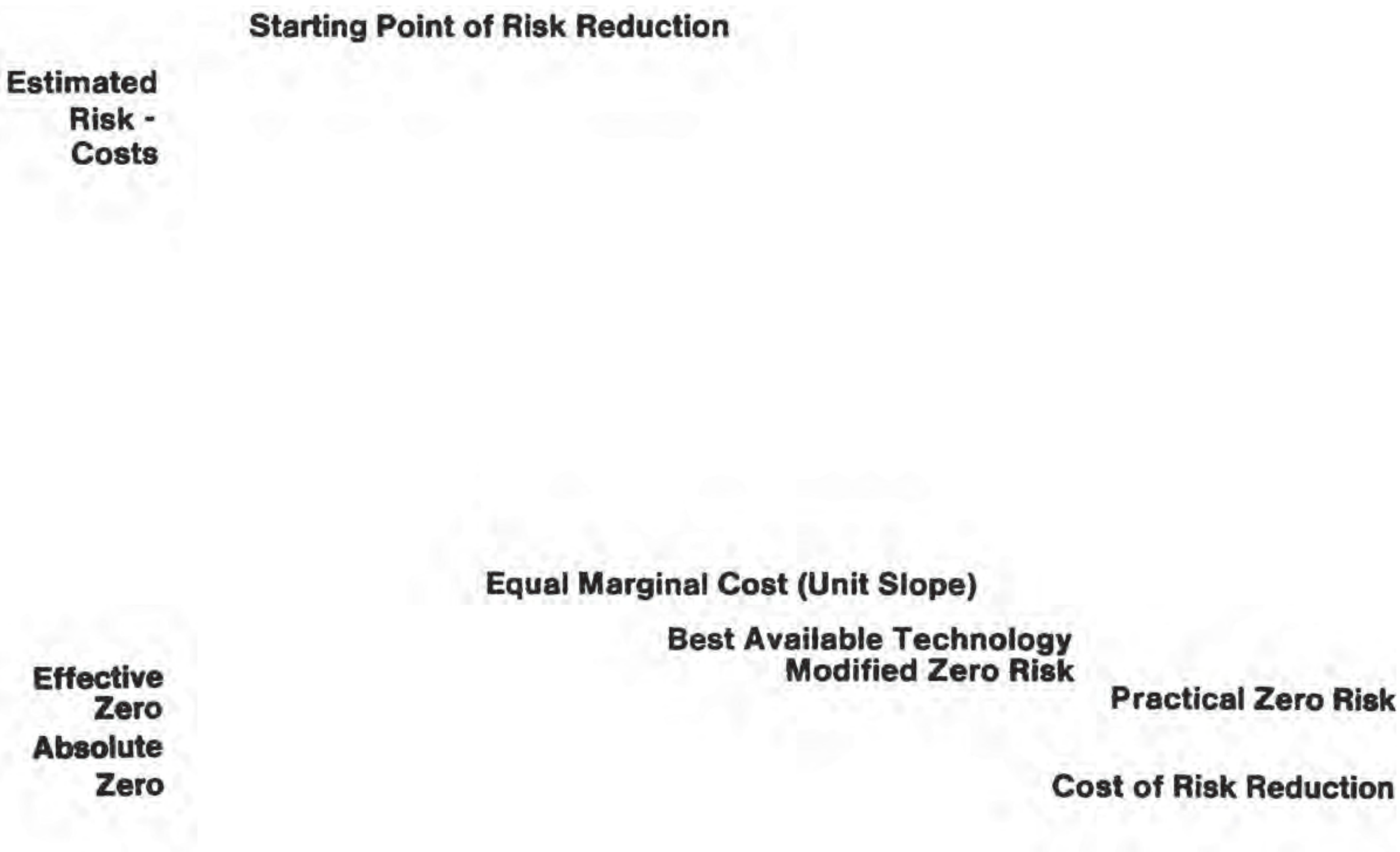
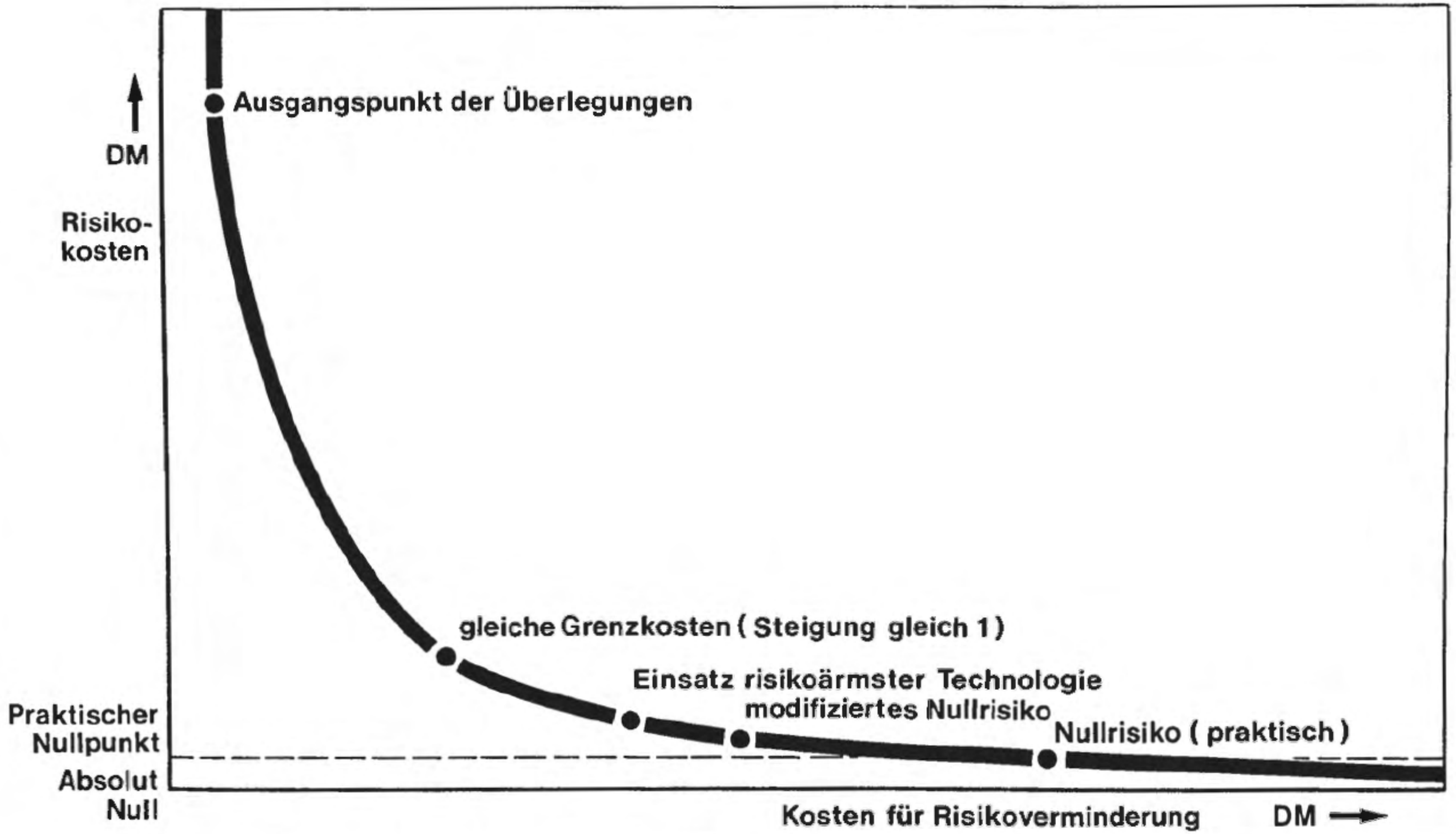

Starting Point of Risk Reduction
Estimated Risk - Costs
Equal Marginal Cost (Unit Slope)
Best Available Technology
Modified Zero Risk
Practical Zero Risk
Effective Zero
Absolute Zero
Cost of Risk Reduction

Fig. 7: Methods to Determine Optimum Risk Minimization



- In addition, the spread of uncertainty is further increased by the infinite number of possible accident profiles, by the fact that certain, entirely unusual chains of events cannot be foreseen and by the limitation, required for technological reasons, to single events or two simultaneously occurring events (common mode failure).

- In probability computations, random failure factors such as human error can be calculated only with reservations. In principle, there are three possibilities for the extrapolation of human error in the manipulation of technological systems:
  - The game theory variant,
  - The probable operator error variant
  - The random operator error variant.

  All three methods are used in modern risk computations. The advantages and disadvantages of these three variants will not be discussed in detail here.

  The variant to be used for estimating a risk is a question of subjective estimation or scientific convention: different results are obtained, depending on which system is used.

The sum total of this risk discussion is that risk estimation by its very nature and under the present state of the art cannot yield objective data in the sense of intersubjective validity. On the one hand, important areas always remain excluded (bounded rationality) and on the other hand it is unavoidable to use subjective judgement in various estimation processes (subjective rationality).

However, it is not intended to create the impression that risk analyses are not meaningful because they cannot yield objective results. First, limited rationality statements are still better than pure intuition, and, second, the usefulness of scientific risk estimates does not consist in establishing an absolute risk yardstick but in developing a basis for a comparison of potential alternatives for achieving a certain benefit (risk-effectiveness method). It is not without reason that especially the probability analyses of risks and risk consequences have very reliably identified weak points in the technological system (German Reactor Safety Commission (GRS), '79, 128, p.43).

What, then, is the information content of probabilistic risk analyses for research projects in the social sciences? The discussion above should already have revealed that this analysis must not be used as a yardstick for the correctness of laymen's perceptions. On the other hand, however, it would be just as unfortunate to believe that any intuitive risk analysis has the same value as a scientifically well-founded risk computation based on a sophisticated methodology. In order to find a meaningful solution ranging between these two extremes, we shall now introduce the model of graduated rationality.

The Graduated Rationality Model

A documentary and a communicative form of perception have been characterized as two important components of the perception model. Both types are specific for second-hand risk perception, i.e. the individual accepts information from other individuals and assimilates that information. In the final analysis, this information can be reduced to experience, associations or intuition.

Association and intuition are procedures which, on average, can claim the least degree of objectivity in the estimation of the magnitude of a risk. Experience, on the other hand, must be considered an objective cognizance instrument, provided that it can be verified by others and is generally applicable. This objective can be achieved only if experience is collected systematically and its information content tested empirically. Most laymen are not able to accomplish this because they lack the resources in terms of time, funds and basic information, in addition to formal training. Therefore, in order to obtain their own notion of the potential consequences of a risk source, laymen adopt the professional analyses via the communication media and expand them with their own associative, observative and intuitive information which, as a rule, cannot improve the degree of objectivity of the professional estimates. The lower the level of dissemination of the considerations prepared by experts, via media, institutions or other means of communication down to the individual citizen, the lower will be the average objectivity to be expected of the arriving message. However, it is quite possible that there are individuals who can detect errors beyond the results passed on by the experts and acquire new insights.

Figure 8 exemplifies the relationships existing between experts' estimates, communicative institutions and laymen's perceptions. The considerations represented in this graph are based on a fictitious risk-benefit source whose true, real risk is given. On a random basis, 50% positive and 50% negative effects have been selected for this graph which, however, does not yet allow any judgement as to whether the risk source in question is acceptable since this would first require evaluation of the consequences. The experts who are predominantly concerned with the risk source will partially penetrate the true structure of the consequences and gain new insights. In addition, however, depending on their basic attitudes, they are also affected by their personal backgrounds, by their attitudes toward the institutions promoting the innovation in question, by intuitively perceived consequences etc., so that they tend to select more positive or more negative aspects from the body of potential consequences. Figure 8 shows a polarization between advocates and opponents from the outset. This polarization is certainly not mandatory, but simplifies the graphic representation. Lack of cognition capabilities, personal interests and erroneous projections have the result that, in addition to the perception of true risk-benefit consequences, each position taken also includes wrongly perceived, erroneous consequences or calculations of their probability, and that it neglects unforeseeable or incalculable consequences (possibly as a deliberate act). The Figure shows a mix of true and false statements and the possibility of subjective influence.

In the next phase, media and institutions (politics, business, school etc.) take up the subject and will in turn add new errors through misunderstandings, selective reception and some subjective interpretations, but will possibly also add some entirely new, valid cognitions based on a flash of intuition. The error ratio will far exceed the ratio of new cognition because the communicators, due to lack of time (not specialized for this particular risk source), lack of specific technical know-how and geometric progression of errors already received from the experts, have only few possibilities of acquiring genuine new information, but all the more opportunity for error.

The normal case is described by a triangle whose broad base is located in the region of new errors while its tip is located in the true risk-benefit field. Only one triangle has been plotted in Figure 8 for simplicity's sake;

Negative Positive

True Risk

Negative
Consequencies

Expert Perception
(Negative Attitude)

Perception of
Social Institutions

Public Perception

Negatively Biased Perception

True Risk

Positive
Consequencies

Expert Perception
(Positive Attitude)

Perception of
Social Institutions

Public Perception

Positively Biased Perception

True Risk

Expert Perception

Perception of Social Institutions

Public Perception

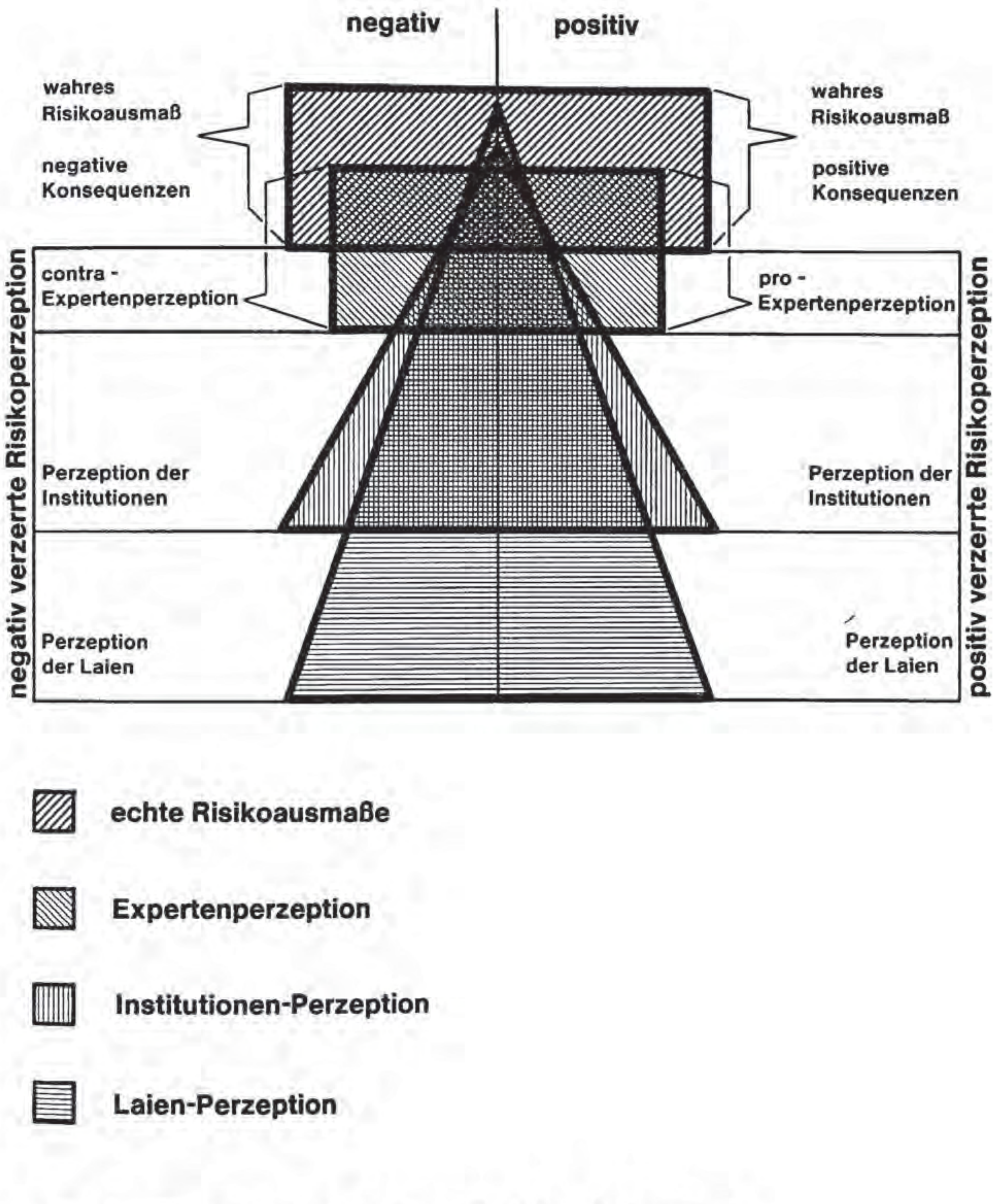


Fig. 8: The Model of Graduated Risk Perception

it is likely, however, that each institution will seek that area which is closest to its own policy. The usual result of this process is an even greater polarization of positions than that which occurs on the expert level, because on that level the more interest-specific argumentation types are excluded by the accepted scientific rules of proof to which institutions are not committed.

On the next-lower level we have perception of the message of the communicators by the public; of course, this can also take place on a third or fourth level. Here, the same mechanism is repeated which already determined the relationships between experts and communicators. Many new errors and misunderstandings, errors transferred during communication from the experts, a small portion of true cognitions and, possibly, some genuine inspirations which go beyond the horizon of the experts, determine the field of general laymen's perception. Again, a triangle shifted to the next level down will represent the perception structure.

Although, in a momentary appreciation, a gradual stratification of rationality between these levels represents a plausible hypothesis, the dynamic interaction process between these levels must not be neglected (Eisenhart/ Krebsbach, '78, 99, p.71 ff.). The limits of information are continuously expanded through questions by the public to the appropriate institutions and transmission of these questions to the experts, because experts frequently tend to overlook certain types of questions. It is also possible that the answers satisfy the public so little that new experts are recruited from the public itself or from other fields of science in order to ensure greater attention to certain aspects not yet satisfactorily clarified.

The model of graduated rationality avoids the error of judging any statement, any evaluation of a risk source - no matter how far-fetched - as having the same value as the expert estimations in the sense of cognition theory. The model demonstrates, on the one hand, the limits for the determination of risks via scientific methodology but, on the other hand, assigns to these risk analyses a priority over the perceptions of laymen. The model can be used to explain the divergent perceptions of experts which should not occur in objective risk estimation , as well as the obvious deviations of laymen's perceptions from logical rationality. It is unnecessary, therefore, to adopt Lennart Sjöberg's proposal that, due to the distorted perception of the experts, common sense should be made the yardstick of risk evaluation (Sjöberg, '77, 522, p.26).

Attitudes and Acceptance

The above discussion of the theoretical starting concept was based on a static overall picture. However, since the acceptance problem involves a process of weighing between different risk elements, a dynamic model is required to describe and translate into empirical terms the individual steps involved in balancing benefit and risk. The process of individual risk acceptance and the resulting formation of attitudes toward the risk source are represented in Figure 9. This Figure shows the individual phases leading to the development of an attitude and, at the same time, incorporates part of the feedback processes. The model starts out from the reception of information on innovative risk sources. This information initially passes three filters: situation-related evaluation patterns, attributive biases, and certain characteristics and value structures specific to the individuals in question (cf. Suchman, '67, 377, p.197 ff.).

Shapes Social Filters

Influencies Credibility of Information Sources

Changes or Stabilizes Perception of Reference Groups

Enforces Selectivity of Matching Attributes to Information Sources

Rejects Information/ Does not Perceive Them

Deminishes Cognitive Dissonance

Enforces or Detracts Attention for Information

Situative Filters

Social Surrounding
Personal Interests
Evaluation of Information Sources

Social Influence Reference Groups' Behaviour Social Norm

Social Rationalizing Social Role Adjustment

Reception of Information

Attributive Filters

Cognitions
- instrumental
- probabilistic

Confrontation with Attitude Pattern

Evaluted Cognitions

Congruency with Overall Attitude Pattern

Decisive Judgement (Acceptance)

Enplacement in Overall Attitudes and Values
Immunizing the Judgement Integrating Judgement into Self-Perception Personal Rationalizing

Dispositive Filters

Attributive Biases
Psychic Properties

Evaluative Biases Perception of Probability Patterns of Decision-Making

Influences Perception and Sympathy for Information Sources

Deminishes Psychic Incongruency

Enforces or Deminishes Readiness to Perceive Information

Sublimes Information

Structures Dispositive Filters

Changes or Stabilizes Elements of Value System

Shapes Dispositive Self-Image

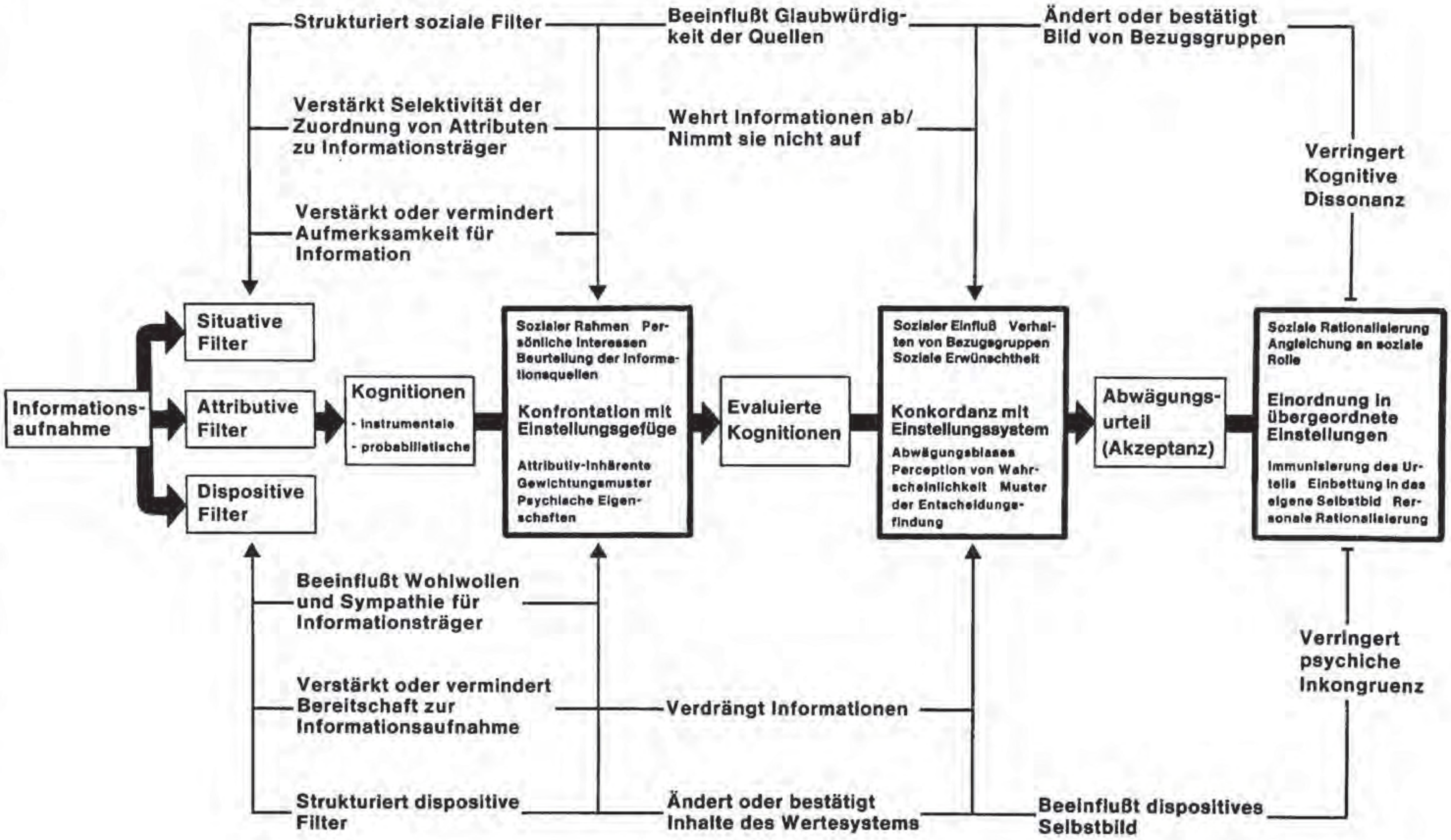
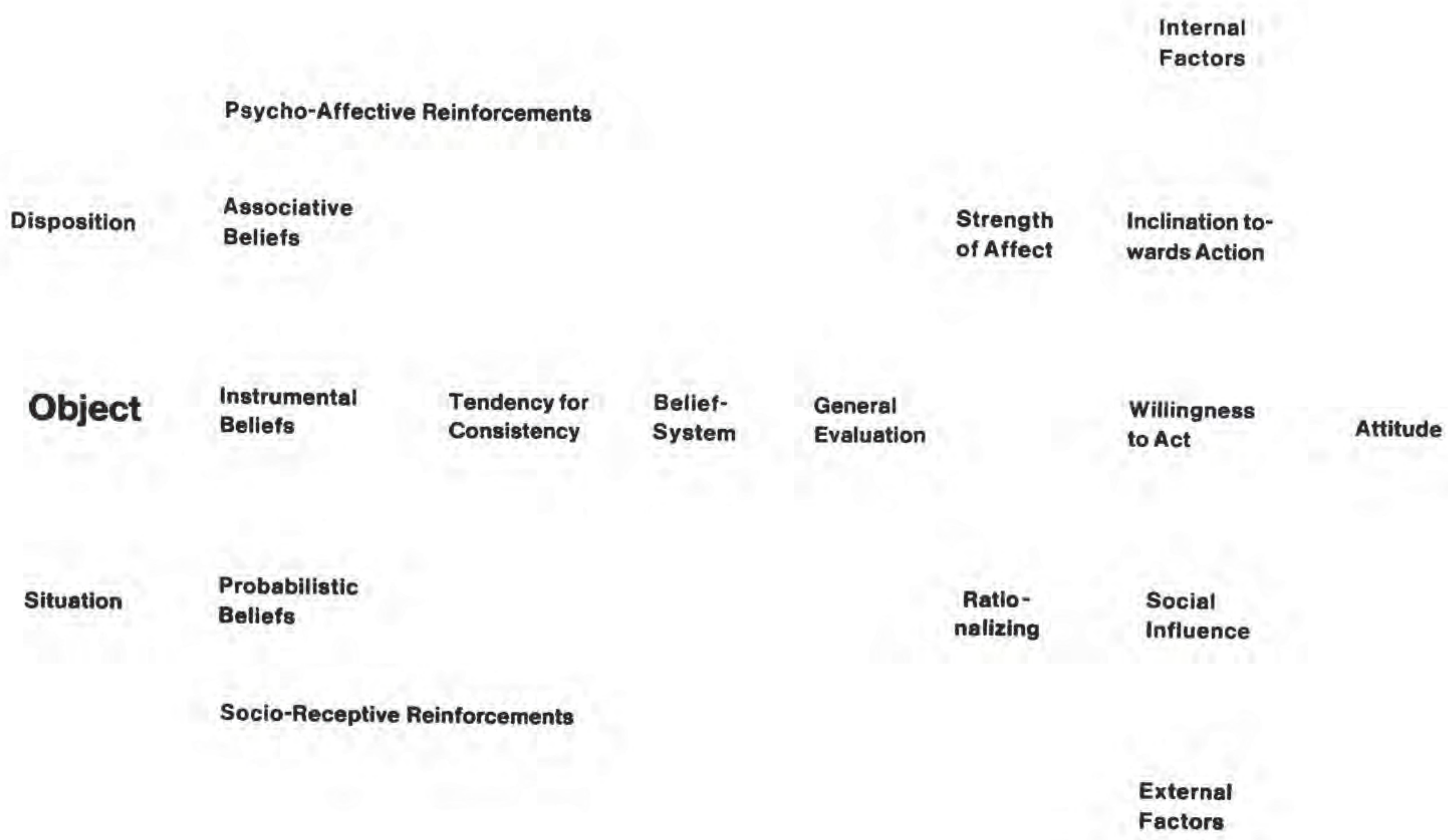


Fig. 9: Model of the Risk Acceptance Weighing Process

The information arriving is preselected by these three filters, and some of its content is re-interpreted. Once the information has been received, it is allocated certain subjective probabilities. This weighting process is certainly not accomplished by means of mathematical formulæ, but by intuitive procedures of the attributive assignment described above. Closely related to the allocation of probabilities is a weighting of cognitive elements in accordance with their subjective significance. The perceived probability of negative consequences certainly has an effect on the assignment of personal weight to these consequences, but there are a number of additional influence factors which result from the perception of the specific damage and from the subjective interpretation of the communicative situation (the interaction field). Among the latter (situational factors) are the social framework of information transfer (such as public lectures, promotion events, TV programmes), the evaluation of the information source (credible, tied to interests, sincere, attractive), the potential effect on oneself (shall I have advantages or disadvantages) and the remaining attitude structure (how compatible is the information with attitudes to similar objects?). The qualitative risk characteristics filtered from the information and the subsequent attributive biases are the personal factors to have an effect on the estimation of the information content. Last but not least, the individual's own preferences, psychic characteristics and internalized attribution patterns should be mentioned.

The passage of this process of weighting information contents will yield a sum total of "valued cognitions" which are compared and balanced in a second phase in order to arrive at a judgement. In this weighing process, the effects of the decision to be made on the individual's role perception, the conformity of this decision with the judgement of potential reference groups and the compatibility with the individual's social image and self-esteem play an important role on the situational level; on the attributive level, biases will effect the decision, and on the dispositive level personal preferences, readiness to accept risk and values concerning the judgement process (such as a tendency toward ambivalent judgement). The weighing process is followed by judgement consolidation: the result of acceptance considerations is substantiated by arguments (rationalization) in order to be protected against external attacks and it is also internally integrated into the belief system in order to maintain a low level of self-doubt. The individual's own social role is reviewed with respect to the decision, and the judgement is assigned its adequate rank in the overall attitude structure. The result of this process is the formation of an attitude.

Feedback processes take place on each level, the primary function of which is to reduce of even eliminate any contradictions (cognitive stress) which might arise. Thus, the decision-making process already structures the future attitude toward biased imformation sources (for instance, ignoring them, acceptance by reference groups). As part of the weighing process, inconvenient concepts and evaluations may be suppressed retroactively and pushed into the background, and the information filters may be induced toward greater selectivity or re-interpretation of irritating information items. Incorporation of the decision into the overall attitude structure precludes the possibility of contradictory experience and the occurrence of psychic inconsistencies. The information filters are so designed that they will receive and process information which supports the individual's attitude, while contradictory information is either not perceived at all, situationally discredited (true information cannot be expected from that source), or dispositively re-interpreted (the disadvantage represented by that source turns out to be an advantage really when studied in more detail).


Internal Factors
Psycho-Affective Reinforcements
Disposition
Associative Beliefs
Strength of Affect
Inclination towards Action
Object
Instrumental Beliefs
Tendency for Consistency
Belief-System
General Evaluation
Willingness to Act
Attitude
Situation
Probabilistic Beliefs
Ratio-nalizing
Social Influence
Socio-Receptive Reinforcements
External Factors

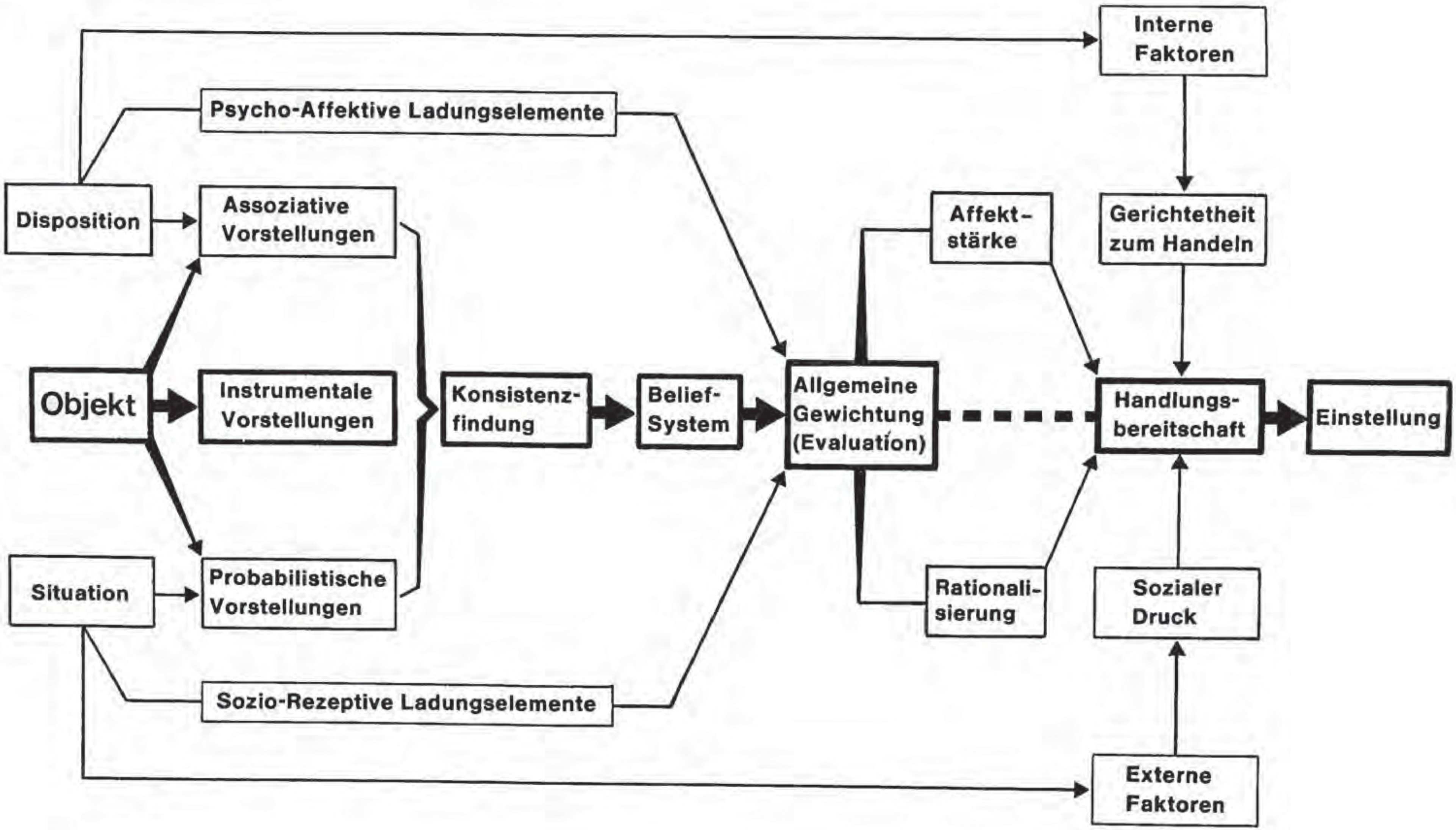


Fig. 10: Basic Attitude Concept

Finally, the cognitions and their associated affective evaluations are combined into an overall judgement and, in addition, a certain bias of behaviour patterns with respect to the risk object is formed. The combination of these three parameters will be defined as attitude. In our attitude concept, the type of linkage between cognitive, affective and conative (conation = behavioural intention) elements is deliberately not fixed. It is based on the theory that attitudes represent mental relations between a perceiving subject and a perceived object. This mental relationship consists of beliefs about the characteristics of the object, of affections toward the object and of the propensity to perform belief-adequate actions (cf. McGuire, '69, 248, p. 142 ff.; Meinefeld, '77, 251, p. 40 ff.). Figure 10 demonstrates the structure of this concept in a summarized graph.

When considering a certain object, the individual develops three types of cognitive beliefs: first, instrumental advantages and disadvantages are associated with the object (such as: generates electric power, improves mobility, causes accidents); the second step consists of adding associative elements (such as: nuclear power station - atomic bomb), and, third, probabilistic associations are made based on the experience with the situation in question (such as: can easily cause a catastrophe, is absolutely safe, etc.). As soon as these motions have become consistent in themselves, we talk about a "belief system". In a second phase, the elements of this system are now weighted in accordance with their subjective significance, a process in which dispositive, individual evaluation patterns (psycho-affective reinforcements) and the perceived reaction of the social environment to the object in question (socio-receptive reinforcement) play an important role.

The emotional alignment which results from this weighted belief system and the degree of argumentative rationalization together with internal factors such as extroversion or straightforwardness, and external factors such as role expectations or social exposure, determine the inclination towards action (behavioural intention). The belief system, its emotional strength and the behavioural intention are interpreted as a single unit which, however, is combined on the basis of individually different summation patterns.

Description of the Different Research Projects for Empirical Analysis

Once the analytical instruments of acceptance and attitude have been defined, the next problem is to translate the general theoretical aspects into empirically measurable indicators. While the analysis of the theoretical basis required a review of the entire field of attitude and its influencing parameters in order to achieve approximation between model and reality, the constraints of time, finite number of data acquisistion capabilities, concentration capability of test subjects and survey respondents, in addition to financial considerations, demand that the most representative possible selection of phenomena requiring explanation be chosen from the number of open problems. In the final analysis, such a selection is always arbitrary, but it can be justified by plausible arguments.

Reviewing once again the most important process links in the acceptance chain and in attitude formation, the following factors appear to be especially in need of explanation:

- The perception filters (attributive, dispositive and situational) and their selection and re-interpretation functions;
- The structure and patterns of belief systems in correspondence to the type of risk sources;
- The effect of situational, dispositive and attributive factors on weighting and weighing of beliefs. The following factors are of primary interest:
  - The significance for the individual's own life,
  - The perceived generalized values of society,
  - The attitude structure of the significant other,
  - Dispositive characteristics,
  - The perception of qualitative risk characteristics and attributive biases,
  - The influence of reference groups and important social institutions;
- The perception of potential alternative risk sources;
- The structure of the attitude and of the preceding rationalization, in addition to the effect of external characteristics on the attitude;
- The degree of rigidity of the attitude and its influencing determinants.

A number of indicators was defined for each of these problem fields which, in turn, were translated into measuring instruments (questionnaires, experiments).

Survey Instruments and Study Cases

The indicators established above cannot be surveyed in one session only since the respondents or test subjects would be overstressed. Therefore, this study was implemented in three phases:

- Implementation of two experiments on attribution processes and qualitative risk characteristics;
- Implementation of two comprehensive surveys on risk perception and risk acceptance on the basis of different risk sources;
- Implementation of a representative survey on attitudes towards nuclear energy and their influencing factors.

The two experiments which will be described in detail in our discussion of the results were carried out in the German town of Jülich. Using a newspaper advertisement, 37 test subjects were selected at random for the first experiment, and 38 pupils (average age 17) for the second experiment.

The comprehensive surveys took place in two towns in Germany, Jülich and Kerpen (in the State of North Rhine - Westphalia). The interviews lasted from one and a half to two and a half hours and, therefore, required an extreme degree of cooperation and concentration ability on the part of the respondents. Since the problem areas under discussion (risk acceptance and perception) are still relatively unstructured and since, moreover, the length of the questionnaire demanded special cooperation on the part of the respondents, a representative selection of the study units was foregone, preferring a stratified selection procedure via quota specifications. Both questionnaires were completed by 50 respondents in Jülich and 50 respondents in Kerpen.

The surveys were carried out in March/April 1979 so that the effects of the Three Mile Island accident could by analyzed as a subsidiary study. Students were trained as interviewers. Their primary function was to read to the respondents the general explanations for the scales and to present the individual scales to the respondents for entering their responses in writing. In addition, they were required to clarify comprehension problems. These were discussed and practised in advance in order to reduce reactive distortions to a minimum. Evaluation of the acquired data was accomplished automatically, using SPSS and SAS computer programs.

The third questionnaire was designed specifically for the nuclear energy problem. All the questions and scales were precisely validated in a preliminary test. The selection of questions and scale items was made on the basis of this validation.

In the third questionnaire, most questions were followed by standardized responses of the multiple-choice type. In addition to improving the precision of statistical evaluation, multiple-choice questions have the advantage that the respondent is not overstressed, that memory gaps are bridged and that concentration can be maintained throughout the interview of approximately one hour's duration. In addition, standardization facilitates the job of the interviewers and reduces the otherwise unavoidable reactive processes (Friedrich, '72, 122, p.32; Scheuch, '73, 386, p.77 ff.).

All response categories were read to the respondents and, where several possibilities existed, specified to the respondents on cards. The only open-ended questions concerned an attempt to determine the perception of nuclear topics in media reporting and the respondent's own associations with respect to nuclear energy. The third questionnaire was used in 5 towns in the State of North Rhine - Westphalia: Jülich, Kerpen, Hamm, Beverungen and Kalkar. Using the records of the municipal registration office, 150 addresses each were selected at random. The surveys were conducted in June, July and early September 1979.

The interviewers included pupils, students and municipal employees who received written instructions and/or an introductory seminar to familiarize them with their interviewer functions and with the questionnaire.

All interviews were announced to the respondents in writing, stating "General Energy Questio as the topic. The notifications were mailed by the Sociai Psychology Institute of Cologne University. For inexplicable reasons, the refusal rate, and also the error rate on the part of the municipal registration office, was very high. Of the 750 addressees only 491 were prepared to grant an interview or could be found at all. In order to have an approximately equal number of respondents per survey area, 12 additional interviews were added, again using a random selection process. Comparison of the sampling data with official statistics showed that the sample represented the marital status (taking into consideration the age limit), confession and age classes relatively well. The men are slightly overrepresented in all the samples. This is not very surprising since it is likely that women are more inclined to refuse interviews on questions involving technology and energy problems. The sample also approximated the data of the populations relatively well with respect to other nominal categories. Obvious deviations from the average distribution with respect to education, income and class did not occur. However, the proportion of environmentalist voters is greater in the sample than it is in the official election statistics. This deviation is probably due to representative distortions (the addressees who voted for environmentalist parties almost never refused an interview) or to consistency attempts on the part of nuclear energy opponents (re-inforcement of their position by stating a false voting behaviour).

On the whole, therefore, caution is indicated when transferring the results to the overall population. However, the good agreement existing between the sample and the official statistics allows basic generalizations and conclusions, especially in the form of relationships between variables.

Jülich and Kerpen were selected as survey location for Questionnaires 1 and 2 in order to obtain an idea of risk acceptance in one town with nuclear energy facilities and another town without such facilities. Since the primary objective was to determine basic structures of acceptance and perception, and since the selection of the respondents was not made on the basis of representative criteria, the selection of these two towns had little significance - apart from the different experience acquired with nuclear energy.

In the case of Questionnaire No. 3, on the other hand, the selection of study units was of special significance. For this questionnaire, five towns in North Rhine - Westphalia were selected, all having a special role with reference to nuclear energy. Since 1958, Jülich has been the site of a nuclear research facility, employing a staff of approximately 3,800, most of whom live within Jülich's municipal boundaries. In Würgassen, a suburb of Beverungen, one of the first nuclear power stations in the Federal Republic of Germany has been operating since the late 60's. This power station has achieved notoriety due to frequent incidents and technological malfunctions (Henrich, '78, 495, p. 17).

The first commercial high-temperature reactor is presently under construction in Hamm; also under construction is the fast breeder reactor in Kalkar.

Kerpen was selected as the control town, for several reasons:

- Kerpen's population is relatively nonhomogeneous. This village agglomeration (population approx. 50,000) includes villages of agricultural predominance, workers' settlements, satellite suburbs and a resettled village (formerly located on a lignite deposit).
- Kerpen's population is fairly familiar with energy problems. A number of lignite-fired power stations operate in close proximity where citizens of Kerpen are employed.
- The author had already carried out a survey in this municipality in 1977 so that time comparisons were also possible.

Of course, it would also have been meaningful to test the questionnaire nationally or throughout the Land of North Rhine-Westphalia. However, the duration of the interview and financial considerations forced us to abandon this original plan. Since, however, quite a number of national surveys on energy problems have been published in the meantime, the results of these questions can be compared to values from the local surveys. Also, relative considerations between the individual variables (such as relation of political party preference to attitude) which are valid for all locations, are likely to describe representative structures although the absolute numerical data will not accurately describe the true value in the total population.

Part III

Socio-psychological Experiments on Specific Risk Perception Problems

The Medical Capsule Experiment - Experimental Setup

A group of 37 persons who had responded to a newspaper advertisement in order to take part in a medical experiment for testing pharmaceuticals was distributed on the basis of their letters and under the random principle into two sub-groups of 18 and 19 persons. Both groups were invited on the same day, but entirely independently of each other, to a neutral location (school building) and each seated in a classroom. On each person's desk was a package with three absolutely identical, commercially available vitamin capsules.

The experimentor, who pretended to be a physician and demonstrated this by wearing a white physician's smock, explained to both groups in identical words that his pharmaceutical company had developed three new capsule coatings, all of which dissolved twice as fast in the stomach as conventional capsules. In order to achieve this, he explained, one capsule was given a weakly radioactive coating, one a bacteria-containing coating, while the third included a ring of heavy metal which was toxic if taken in greater quantities. The experimentor emphasized that the quantity of these materials contained in the coatings was so small that a health hazard was absolutely excluded. The capsules, he said, were filled with natural vitamin preparations so that the test subjects would be doing something beneficial for their health. In order to demonstate the harmless nature of the capsules the experimentor swallowed all three capsules one after the other in the presence of the test subjects.

Subsequently he requested the members of Group I to select any one of the three capsules and swallow it. In Group II the experimentor directed that the first six test subjects take the first capsule, the second six subjects the second capsule, and the remaining subjects the third capsule.

Percentage of
Self-Revealed
Sufferings

Heavy Metal Capsula 1

Bacteria Capsula 2

Radioactive Capsula 3

Variance of Experimental Design

Group II (Involontary Risk-Taking)

Group I (Volontary Risk-Taking)

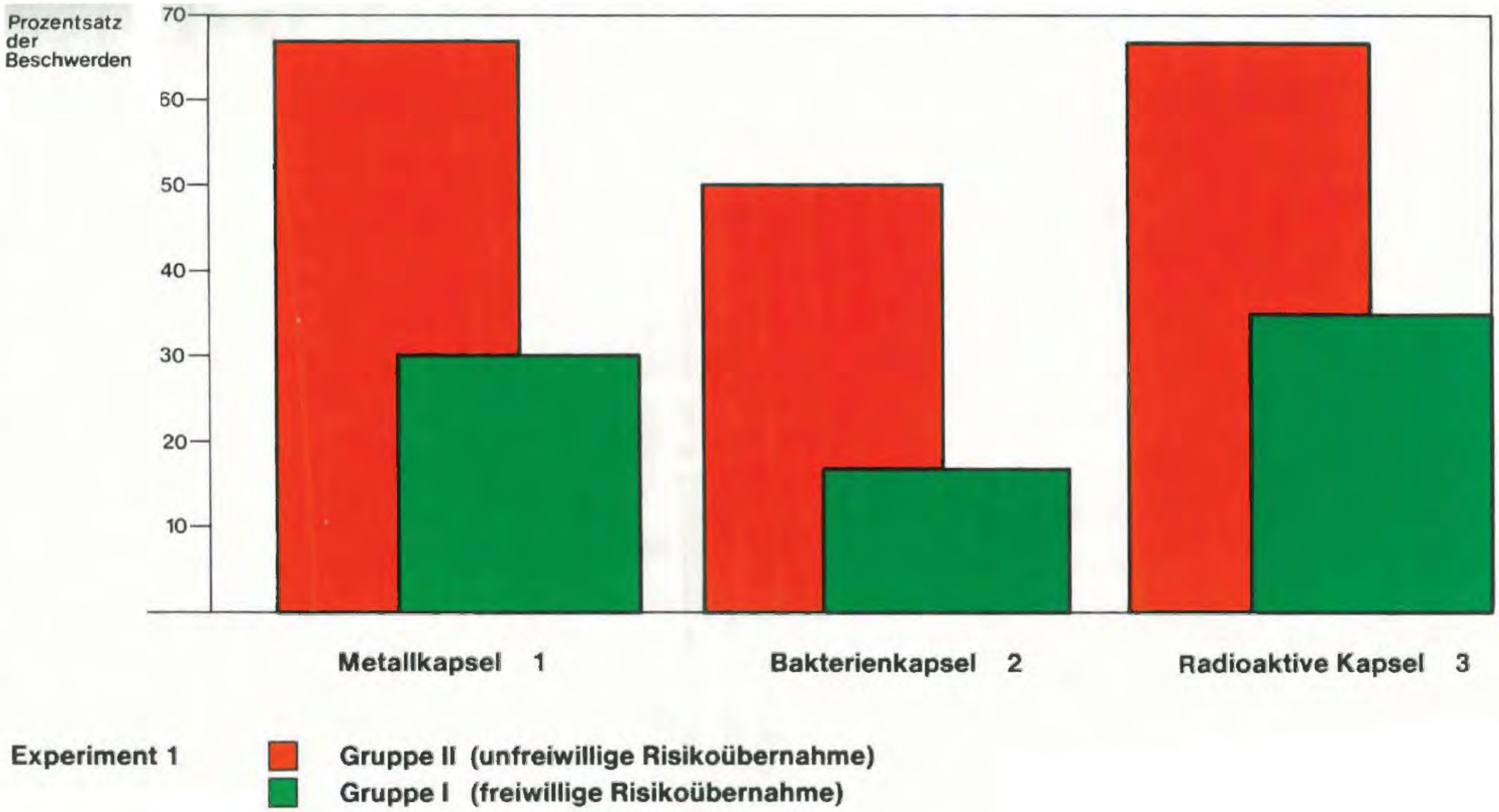


Fig. 11: Results of Medical Capsule Experiment

After 15 minutes the respondents were requested to state whether they felt any complaints and which of the three capsules they would prefer to purchase, provided that all three were absolutely identical with respect to the amount of risk involved and their medical effectiveness.

The basic pattern of this experiment was based on a simple factorial design (Zimmermann, 1977, 475, pp. 154-55). The Y-values of the two independent variables (complaints, purchase decision) at the same time served as control parameters so that a separate control group was unnecessary for the test. The test setup can be described by the following schematic:

Group I: stimulus 1 (voluntary) $X_1 \rightarrow M_1 \rightarrow M_2$
Group II: stimulus 2 (assignment) $X_2 \rightarrow M_1 \rightarrow M_2$.
X = stimulus; M = measurement.

It was attempted to reduce reactive distortion to a minimum during the implementation of this experiment. The test subjects were seated in a classroom which was absolutely identical for both groups. In order to achieve a constant influence on the part of the experimentor, the groups were invited at different times so that the same experimentor faced both groups, exemplifying the same degree of authority and credibility.

Results of the Medical Capsule Experiment

Table 5 and Fig. 11 provide an idea of the different behaviour patterns between the members of Group I (voluntary risk-taking) and Group II (involuntary risk-taking). Two basic insights can be obtained from the data:

- Compared to Group I, more than double the number of test subjects in Group II, stated that they felt some kind of complaint after taking the capsule. This significant relationship (p = 0.05) supports the assumption that voluntary risk-taking causes lesser aversion than involuntary risk-taking.

- In spite of the given identical risk level it is seen from both the free selection of the capsule and the specific distribution of complaints based on the different methods of taking the capsules, that the type of risk source initiates preferences - probably via associative trains of thought - which are independent of the level of the given health risk.

The assumption that voluntarily reinforced risks are more acceptable than externally reinforced risks is presented in almost all risk perception studies reported in the literature (such as Starr, '69, 406, p.1232 f.; Slovic et al, '77, 367, p.12 f.; Otway, '77, 297, p.5; Scharioth/Krebsbach, '77, 382, p.21). And this assumption appears intuitively correct. However, the validity of this hypothesis has never been demonstrated experimentally. To date, empirical testing of the voluntary acceptance thesis has been confined to two procedures. Ch. Starr studied the risk sources accepted by society and classified them as voluntary and involuntary risks. Subsequently, he determined the average loss rate, related it to the benefit rate and computed the differences between the two risk groups. However, his global comparison yielded different quantitative results: the acceptance rate for voluntary risk sources is greater by a factor of 1,000 than the acceptance rate of involuntary risk sources (Starr, '69, 406, p.1236).

Fischhoff et al. used a semantic differential for interviews where the subjects were requested to assign the voluntary and involuntary criterion to different risk sources, and subsequently used statistical analyses to

Table 5: Subjectively perceived complaints after voluntary (Group I) and involuntary (Group II) ingestion of tablets

Experimental group	Ingestion Complaints in % Radioactive capsule	Metal capsule	Bacteria-containing capsule	Purchase decision Complaints in % Radioactive capsule	Metal capsule	Bacteria-containing capsule	Deviations between purchase and selection in %	n
Group I	34	30	17	34	17	11	11	19
Group II	67	67	50	56	28	28	44	18
n	9	16	12	9	16	12	37	37

obtain conclusions as to acceptance, measured in the form of risk-benefit estimates (Fischhoff et al, '78, 112, p.147). The authors arrived at the result that risks reaching high values on the voluntary scale tend to have low values on the risk estimation scale. The study fails to report on quantitative relationships, which is very meaningful considering the methodical-causal explanation value of this indirect measurement.

The Poisoned Water Experiment - Experimental Setup

Senior students from two courses (average age 17, total of 38 persons) were divided into two equal groups under the random principle. The experimentor described the following situation to both groups:

"A lethal poison occasionally occurs in the ground water of town X which can enter the households via the water supply. People who drink this water will die immediately and cannot be saved. There are several options for handlimg this problem:

- Installation of a central poison sensor (failure probability once in 220 years; loss rate 7,260 citizens);
- Installation of ten regional poison sensors (failure probability once in 19 years; loss rate 627 people);
- Installation of automatic home poison sensors (failure probability 11 systems per annum; loss rate 3 people);
- Installation of manually operated home poison sensors (failure probability 38 % lower than for the third solution, provided the apparatus is handled properly, otherwise 15 failures per annum. An average of 33 dead per annum can be expected).

All four solutions are equally expensive and are exactly on the limit of the funds available to town X for the safety system. Any other solution, or any combination of the solutions, is impossible for financial and technical reasons."

After presenting this basic situation, which was communicated to both groups orally in detailed form and summarized in writing, all pupils were given the same questions, but in a different sequence. A questionnaire had been prepared for each question so that, after responding to a question, the next-following questionnaire was not distributed until the preceding questionnaires had been collected.

The pupils were requested to state the following:

- How high would they assess the risk for each variant on a scale from 0 to 10;
- Which variant would have their personal preference;
- How much money they would have to be offered (max. DM 10,000) in order to move to the town using the selected variant;
- Which variant they would prefer when voting in the municipal council.

Two additional questions, identical for both groups, followed: First, the pupils had to select between one valve costing DM 1,000 and having a failure probability of once in 100 years, and two valves costing DM 500 installed parallel having a failure probability of once in 12 years each (both possibilities were also explained in graph form); the second question consisted of asking for the degree of difficulty and understandability of the problems given to the students.

The experiment was designed so as to provide answers to three questions:

- Are equally probable events (33 dead p.a. each) also classified with equal risk if their characteristics differ with respect to the centralized-dezentralized dimension and the active-passive dimension?
- Are risk sources of dezentralized structure and/or with a possibility for conducting one's own inspections preferred intuitively?
- Does the decision remain unchanged when a collective solution is to be attempted instead of the personal preference?

The basic situation described by this experiment appears fairly artificial at first glance. However, several pretests using similar questions had shown that the type of experimental setup described above is feasible for students.

Discussing the hypothetical structure: Strictly speaking, this experiment is a quasi-experiment. On the one hand, there is no control group for each variable and combination of variables, and, on the other hand, the experiment does not seek to determine actual behaviour, but hypothetical behaviour. The experimental type can be characterized by the following schematic:

Group I: $X \rightarrow Y$: Z1, Z2, Z3
Group II: $X \rightarrow Y$: Z3, Z1, Z2

In this schematic, Y is the risk evaluation, Z1 the personal selection, Z2 the income statement and Z3 the vote delivered in the municipal elections. This setup represents a combination of factorial design and Latin square (Zimmermann, '72, 475, pp. 154 ff. and 166 ff.; Campbell/ Stanley, '63, 49, p.66 ff.).

Results of the Poisoned Water Experiment

The most important results of these experiments have been compiled in Tables 6, 7, 8, and 9. Table 6 lists the deviations from the uniform distribution concept for determination of the risk level. More than two thirds of the test subjects either failed to recognize the concealed uniformity of the risk level (33 dead p.a.) or did not use the number of dead as the sole yardstick for estimating the risk level.

The absolute and percentage values for all four basic questions have been compiled in Table 7. A preference for the in-house solution with a personal verification can be seen clearly from the individual decisions (the difference to the variant evaluated lowest in each case is significant); the result is less striking in the case of the desired solution for the community. Apparently, therefore, the test subjects feel that other citizens would be less reliable in handling the poison sensor equipment, since in-house solutions with a personal verification would no longer be preferred in either group. This represents an interesting divergence between the task of evaluating the risk for oneself or a risk for the community. Table 8 summarizes the most important justifications given for the selections made between the four risk variants. The subjective justification given for one's own hazard is approximately in keeping with the expectation that advocates of centralized solutions emphasize more the improbability aspect (temporal component), while the advocates of decentralized solutions tend to favour the damage level aspect (multitudinal effect). However, two insights are surprising:

- Contrary to the assumption presented by many authors, it appears that the probability of an accident (temporal component) does have a significant effect on risk perception. At least this applies to still overseeable time frames.

- The in-house solution is preferred not only because of its low catastrophic dimension (multitudinal effect), but predominantly on the basis of the idea that this concept would be more democratic and represent equal distribution of risk among all (objectively, of course, the random nature of exposure is just as high as it is for the other variants).

- Table 9 shows the results from the additional question concerning the preference between valve systems. The question as to whether the test subjects would prefer one valve having a failure probability of 1 : 100 or two parallel valves having a failure probability of 1 : 12 each, 69 per cent selected the obviously false solution. This tends to support the assumption that probabilities are more likely to be added than multiplied. There were no significant differences between the two experimental groups.

Table 6: Deviations from the uniform distribution of risk estimates

Number of errors	Structure of the estimated values	Absolute frequency	Relative frequency
0	a a a a	6	15.4
1	a a a b	7	17.9
2	a a b b	14	35.9
3	a a b c	8	20.5
4	a b c d	4	10.3
		39	100

Arithmetic mean: 1.92 errors

Table 7: Results of the poisoned water experiment, subdivided by the two experimental groups

Group decisions	Risk estimation median	Personal selection preference in %		Municipal election preference in %		Money
Group I *						
centralized decentralized in-house verification	4.8 4.9 4.7 4.4	5 3 3 8	26.3 15.8 15.8 42.1	6 4 4 5	31.6 21.1 21.1 26.3	6578 7120 6890 3440
Median		3.0		2.4		
Difference between risk estimations	not significant	significant		not significant		sign.
Group II **						
centralized decentralized in-house verification	4.4 4.5 3.9 4.0	3 2 7 7	15.8 10.5 36.8 36.8	4 3 8 4	21.1 15.8 42.1 21.1	4830 4830 3280 3025
Median		3.1		2.8		
Difference between risk estimations	significant (0.96)	significant		significant		not sign.
Both groups						
centralized decentralized in-house verification	4.6 4.7 4.4 4.2	8 5 10 15	21.1 13.2 26.3 39.5	10 7 12 9	26.3 18.4 31.6 23.7	5922 6204 4363 3246
T-test I with II	not significant	not significant (0.42)		not significant (0.33)		sign. (0.95)

* Group I: personal preference requested first, community preference last

** Group II: community preference requested first, personal preference last.

Table 8: Justifications given for the selected risk variant (summarized by the author)

Group I (pers. preference)	Number	Justification given
Centralized	5	Unimportant for subject's own life, highly improbable, historical time frames
Decentralized	3	Long period of time, no catastrophic effects, low probability of being affected
In-house	3	Low probability of being affected, all are affected equally
Verification	8	Risk can be personally controlled, personal influence, risk lower than in the other variants, victim has to blame himself, caution is rewarded
Group II (collective decision)		
Centralized	4	Low risk, technological progress is likely in 220 years, long time frame, possibility of evacuation
Decentralized	3	Divided risk, no catastrophic effects
In-house	8	Risk shared between all, town remains in existence, no personal privileges, each bears the same risk, lower losses to the economy
Verification	4	Reward for cautious persons, lesser risk due to education, culpable behaviour

Table 9: Perception of Redundance

Group	Correct Solution n	Correct Solution %	False Solution n	False Solution %	n
Group I	6	35	13	68	19
Group II	5	26	14	74	19
n	11	31	23	69	38

t-test: sig = 0.69

Evaluation of the experiment by the students was predominantly positive: approximately 60 % found the text understandable, the instructions unambiguous and the problems clearly defined. Two students stated that they could not handle the problems at all (5.3 %). Some of the remaining students criticized that the problems were difficult to understand (10.6 %), that the problems were not transparent (18.4 %), or that the performance demanded of them was not clearly enough defined (13.2 %). Considering the highly artificial and complex experimental setup, this number of critical comments does not appear to give cause for concern.

An attempt to summarize the most important results of this experiment will yield the following conclusions:

- Given identical risk level (detrimental effects per annum) there is neither a uniform distribution in the perception of the risk level nor in the evaluation of the risk source, provided that the risks differ in their qualitative characteristics.

- In the case of redundant safety systems the effects of design redundancy are not multiplied in the perception of the test subjects, but probably added.

- With respect to the problem of the acceptance of centralized vs. decentralized facilities it appears that the extremes of the different possibilities, entirely centralized and entirely individualized, are preferred, provided that in either case the time frames and damage dimensions still remain overseeable for the individual.

- In the question as to the effect of personal verification capabilities it appears that, in the case of individual risk acceptance, active control by the individual has a positive effect on acceptance while this factor does not play a significant role in the case of collective risk acceptance.

- Individualized risk sources (in-house solutions) are preferred by many respondents, not only for risk-internal reasons but also from the feeling that individual risk assignment is associated with uniform and just risk distribution, although any random distribution is just as evenly spread in reality.

- Risk estimation, personal preference, and amount of compensation payments are closely correlated. Consequently, the individual attempts to build up in his mind a fairly consistent pattern of the different dimensions of risk evaluation.

However, when interpreting these results it should not be overlooked that the experimental setup was fairly artificial and that the experimental structure failed to meet the methodological requirement for an independent control group. Consequently, the conclusions drawn from the results above are more of an exploratory nature.

Part IV

Individual Risk Perception - Results of Comprehensive Surveys

Effect of Risk Levels (Expected Values) on the Evaluation of Risk Sources

In probabalistic risk analysis the risk level is determined from the product of probability of occurrence and the magnitude of consequences. The degree to which this normative model also describes the intuitive risk assessment should be clarified by means of the following questionnaire structure:

- allocation of average losses per year (deaths, injuries, property damage) to different types of risk sources;
- allocation of average losses in an especially catastrophic year to be expected during one life span;
- abstract risk-benefit estimation of risk sources;
- future procedure with respect to risk sources (from support to prohibition).

Several American studies use similar indicators, some of which were used as models for this investigation. In particular, the studies by Fischhoff et al should be mentioned here. The results of these studies shall be briefly summarized:

- the quantity of rare lethal consequences is overestimated while everyday risks are underestimated. The true risk levels fluctuate from sixty to about one million while the perceived span ranges only from 120 to about ten thousand (Fischhoff et al, '78, 113, p. 33).
- Overestimated risks are usually of a dramatic nature with high sensational content and broad publicity effect. Underestimated risks are usually of an everyday nature, include a continuous loss rate and do not always have lethal consequences (for instance diabetes) (Slovic, '79, 371, p. 15).

- In estimating the losses of especially serious catastrophes the average pattern is to use a multiplier of only 1.5 compared to the normal estimate. It is only in the case of sensational, broadly published potential catastrophes that significantly greater factors are named in some cases; thus, for spray cans a factor of 2.42 is named, for pesticides a factor of 2.37 and for nuclear energy a factor of 87.6 (Slovic et al,'78, 368, p. 10).

Figure 12 provides an idea of the discrepancy between real and perceived risk levels, according to a survey by Fischhoff, Slovic et al. The curve profile clearly indicates the similarity of the extreme values and the underevaluation of every-day risk sources and the overevaluation of dramatic risk sources.

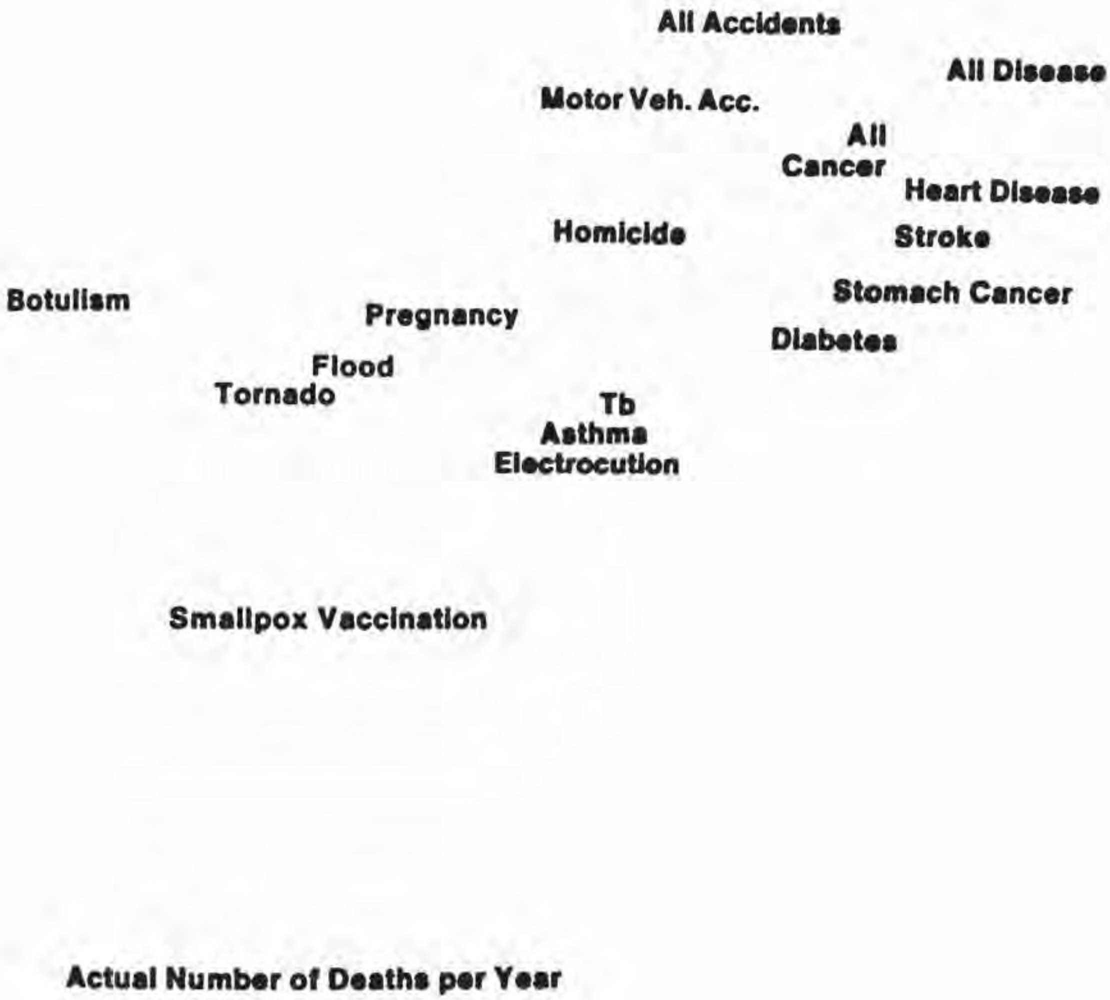
Before discussing the results of our study in comparison to the American data, the selection of risk sources should be described briefly.

First of all, we could take into consideration only those risks for which fairly reliable data to determine the expected values were available. Secondly, a number of content requirements had to be satisfied. On the one hand, we had to select homogeneous risks whenever possible, since our theoretical model provides that individuals do not have any universal risk perception mechanism but, at best, develop similar strategies to cope with uncertainty and the threat of danger under different risk classes. On the other hand, the validation of this theory which is a subject of dispute in the literature, required the selection of heterogeneous risks wherever possible in order to be able to demonstrate that different risk classes are also associated with different perception patterns. As a compromise between these two requirements only civilization-caused risk sources were taken into consideration, meaning that natural risk sources (earthquake, hurricane etc.) were excluded. However, within the spectrum of civilization-caused risks, examples were selected which approximately cover the entire range of civilization-caused risks, i.e. technologically-induced, culturally-induced and habitual sources.

Three additional boundary conditions were imposed to ensure comparability:

- all risk sources should have some characteristic in common with nuclear energy, the reference parameter;
- the selected risk sources should vary in the degree of their acceptance by society;
- the selected risk sources should differ in their qualitative characteristics (such as the voluntariness of risk-taking).

In accordance with these conditions the following risk sources were selected for the category of technologically-induced risks: X-ray (radiation being the common characteristic with nuclear energy), electrical appliances (electric power being the common characteristic), pesticides (carcinogenic effect being the common characteristic), motor cars and aircraft (energy and possibility of accidents being the common characteristics, intercomparability also exists), automation on the job (instrumental function being the common characteristic) and, finally, coal-fired power stations as a direct alternative to nuclear energy. Among the habitual risks, three habit-forming products were selected, because of their class-specific comparability and their variable degree of acceptance by society: cigarette smoking, alcohol and heroin. Similar to the nuclear energy risk, harmful effects on health can be expected from all three risk sources.


All Accidents
All Disease
Motor Veh. Acc.
All Cancer
Heart Disease
Homicide
Stroke
Botulism
Stomach Cancer
Pregnancy
Diabetes
Flood
Tornado
Tb
Asthma
Electrocution
Smallpox Vaccination
Actual Number of Deaths per Year

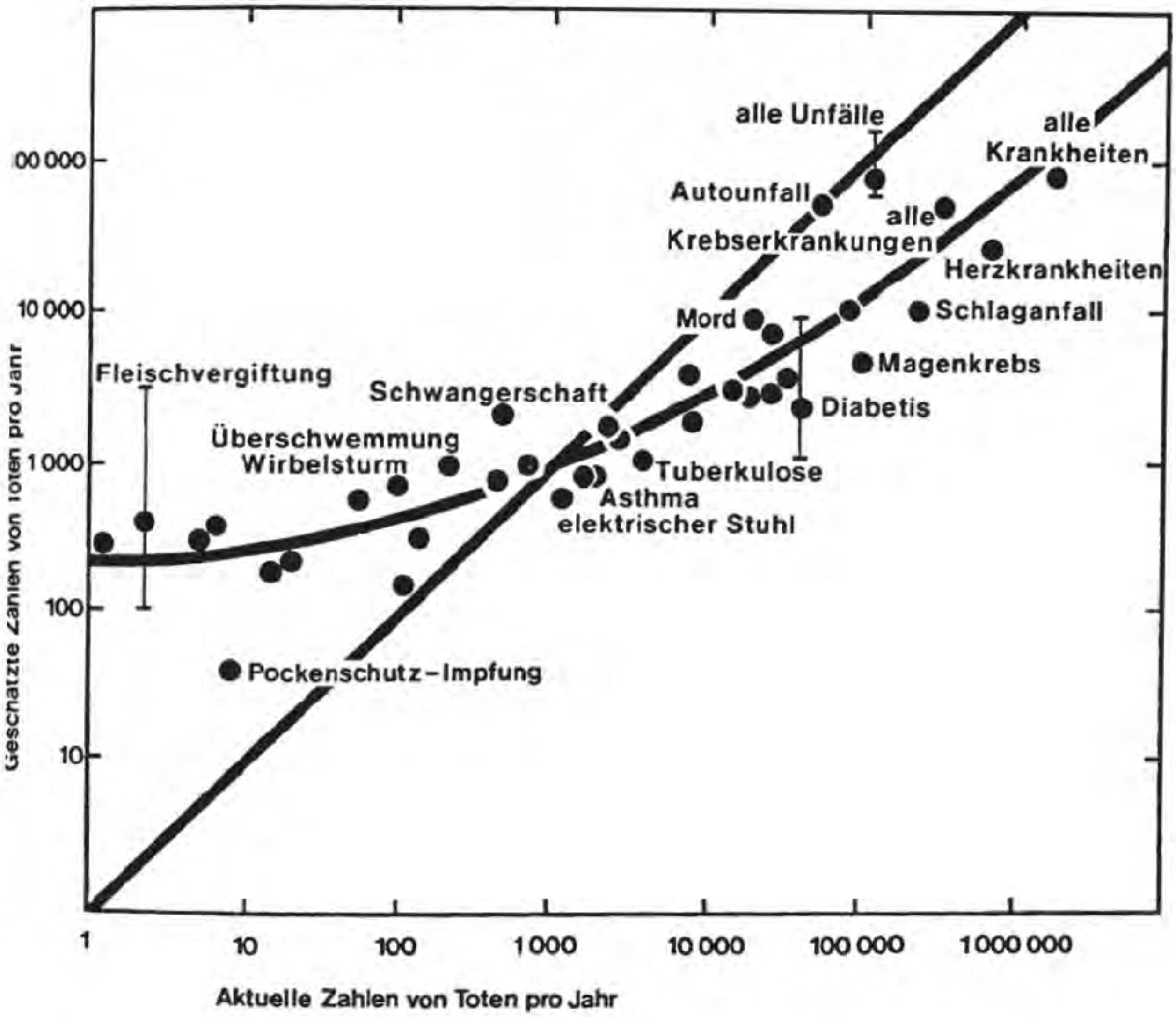


Fig. 12: Discrepancy Between True and Perceived Fatalities
(U.S. Data acc. to Fischhoff)

Especially problematic was the inclusion of culturally-induced risks such as leisure occupations, sports and artistic activities. The pretests had revealed heavy resistance on the part of the respondents even to perceive these forms of risk as being risky at all and to fill in a belief scale on these relationships. The only risk sources which yielded a response pattern which could be interpreted in any meaningful way at all remain motor car racing, gliding and skiing.

Therefore, in order to avoid overlapping with motor car driving and air traffic in general, only the skiing risk was included in the main study. However, this risk source has nothing in common with nuclear energy. Therefore, it is merely used as the control variable in the analyses to follow.

The first task assigned to the interview subject was to estimate the losses (deaths, injuries, property damage) for each of the risk sources listed. The figures for the field of private cars were provided to the respondents so that they would have a starting point for their estimations. The results of these interviews have been compiled in Table 10, and several indices have been listed in this Table to summarize the data.

The abstract estimates are of secondary significance. Rather, the difference between the estimate made by the population and the data contained in the official statistics are of interest. Figures 13 a-c show a comparison of the median values for the two classes of variables. In Figure 13 a, logarithmic scale was used to establish a relation between real losses and estimated losses during an average year, in Figure 13 b the same relation has been plotted for the loss estimates in a catastrophic year and in Figure 13 c the data are again plotted for an average year but this time using a mixed scale: logarithmic for the official data and linear for the estimated values. What are the conclusions to be drawn from the Table and from these figures?

- The span for the estimated deaths (normal year) ranges from 130 to approx. 17,000, while the real, statistically determined values range from 22 to 99,000.

- Low loss rates are easily overestimated, while high loss rates are more likely to be underestimated.

- The multiplier for loss estimates between normal years and a catastrophic year is on the average approximately 2.04 (and, therefore, slightly greater than in the American studies). Some sensational or often-discussed risks and risks causing conceivably great losses are extremely overestimated with respect to catastrophic perception capabilities. For pesticides and X-rays, 10 times the number of deaths was estimated, for coal-fired power stations 17 times the number of deaths, for skiing accidents 32 times and for nuclear facilities 2,360 times the real number of deaths. The differences between average year and catastrophic year are slightly reduced when an index is computed from deaths, injuries and property damage instead of merely using the fatalities as the reference parameter; however, the basic relations remain unchanged.

- The estimates of losses for an average year approximate the true data from the statistics fairly well. The correlation between the respective medians is 0.78.

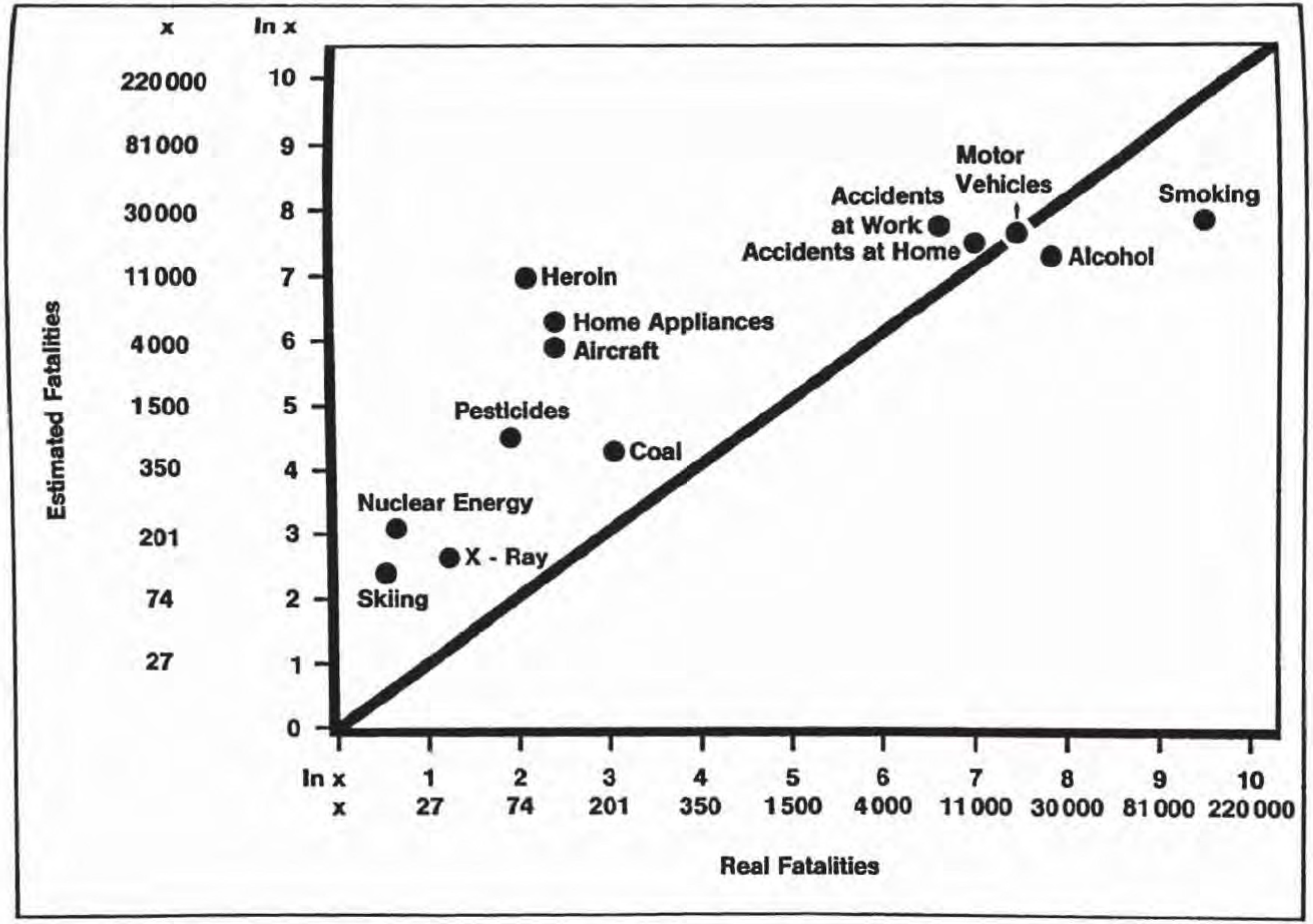
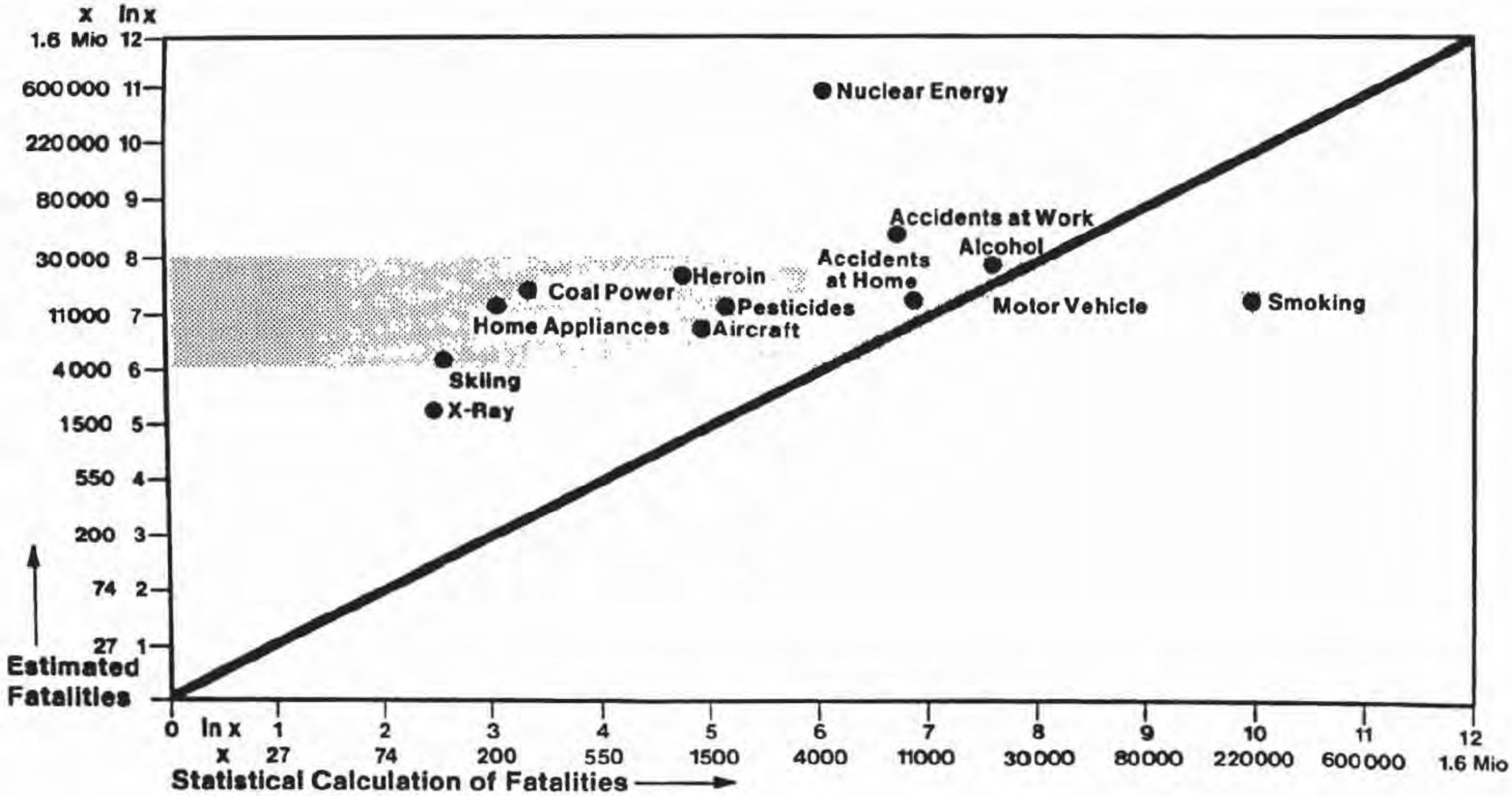


Fig. 13 a: Discrepancy Between True and Perceived Fatalities for an Average Year (German Data, Logaritmic Scale)



x ln x
1.6 Mio 12
600000 11
220000 10
80000 9
30000 8
11000 7
4000 6
1500 5
550 4
200 3
74 2
27 1
Estimated Fatalities
Nuclear Energy
Accidents at Work
Alcohol
Accidents at Home
Heroin
Coal Power
Pesticides
Home Appliances
Aircraft
Motor Vehicle
Smoking
Skiing
X-Ray
0 ln x 1 2 3 4 5 6 7 8 9 10 11 12
x 27 74 200 550 1500 4000 11000 30000 80000 220000 600000 1.6 Mio
Statistical Calculation of Fatalities

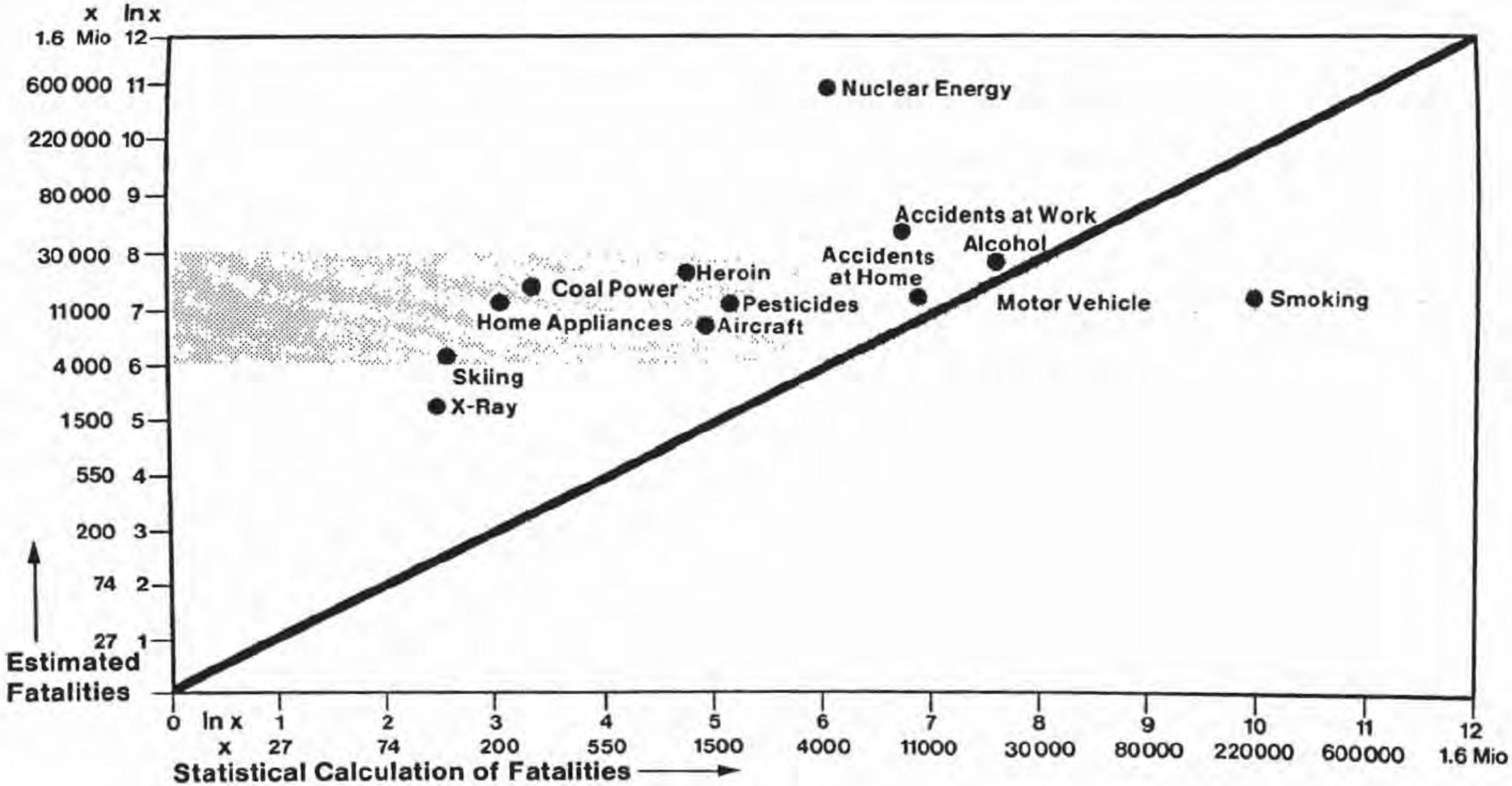


Figure 13 b: Discrepancy Between True and Perceived Fatalities
for a Catastrophic Year
(German Data, Logarithmic Scale)

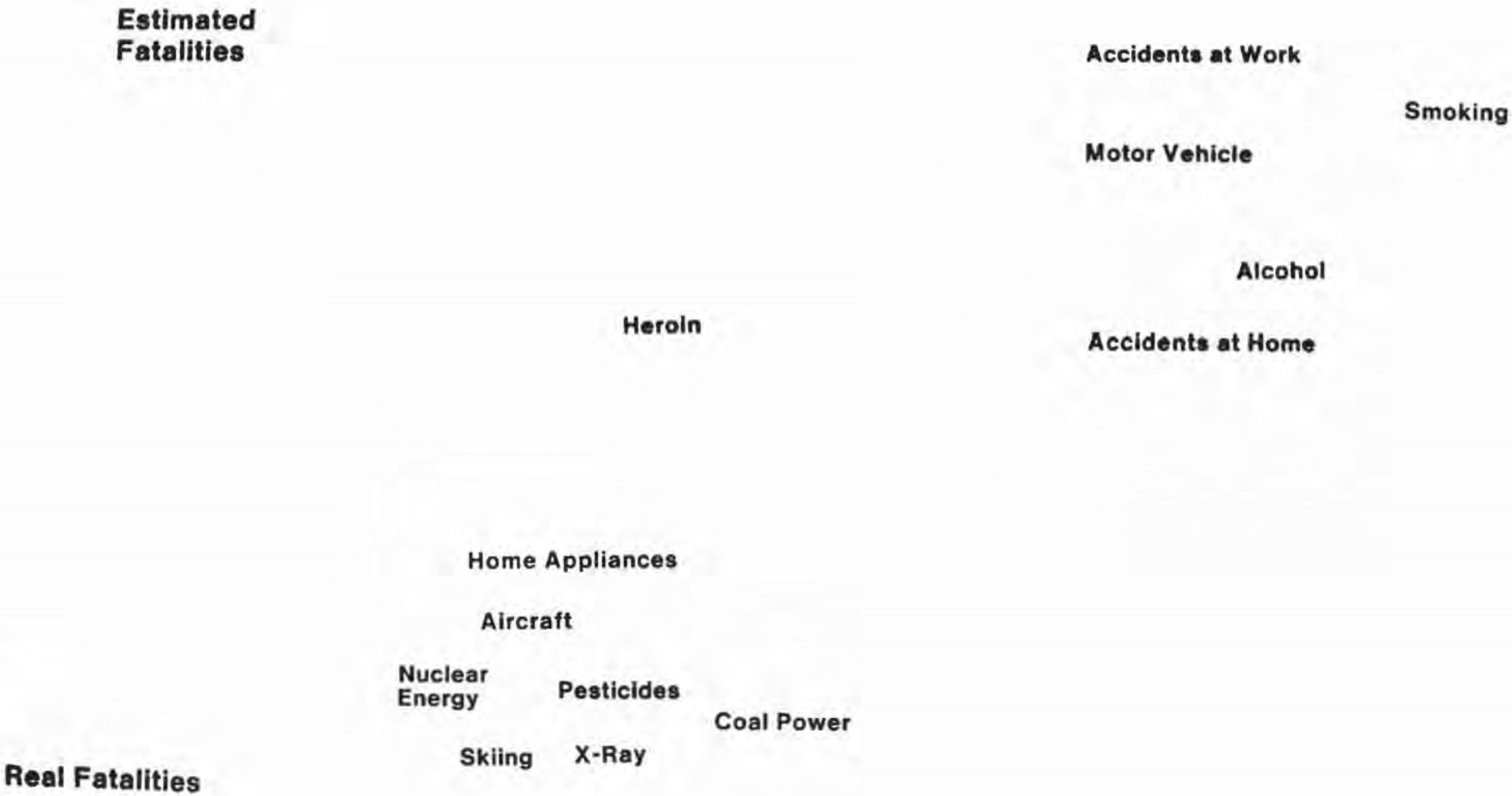

Estimated Fatalities
Accidents at Work
Smoking
Motor Vehicle
Alcohol
Heroin
Accidents at Home
Home Appliances
Aircraft
Nuclear Energy
Pesticides
Coal Power
Skiing
X-Ray
Real Fatalities

Fig. 13 c: Discrepancy Between True and Perceived Fatalities
for an Average Year
(German Data, Mixed Scale)

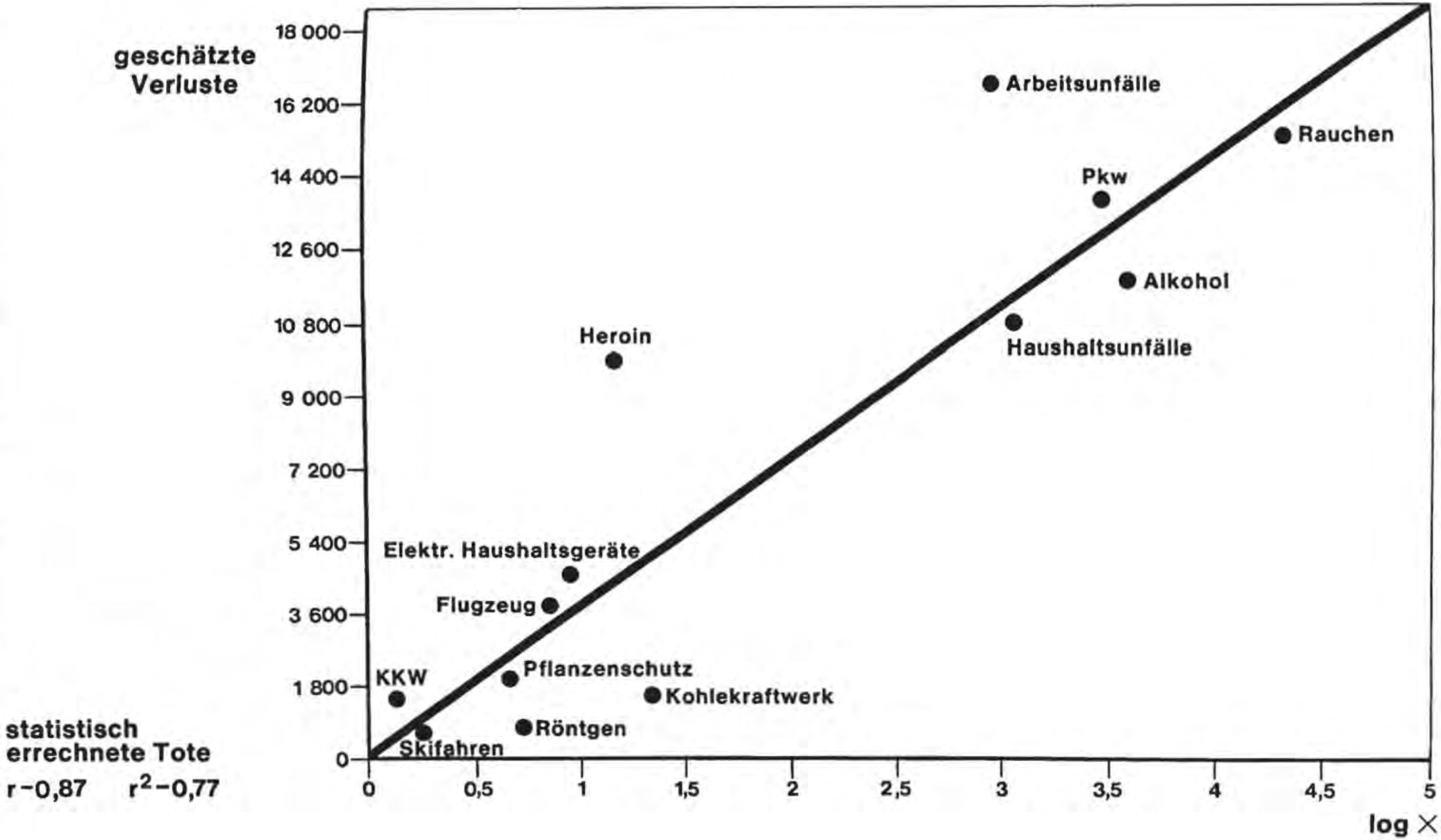


Table 10: Estimated Losses from Different Risk Sources

Risk source	Losses Estimated deaths per normal year	Estimated deaths for catastrophic year	Index: Estimated losses (deaths, injuries, property damage) per year	catastrophic year	Difference between normal year and catastrophic year	Index: Total losses with one catastrophic year per 100 years	Ranking of total loss index
Accidents on the job	17,438	35,515	251.8	452.8	201.0	256.3	2
Smoking	16,629	16,365	217.5	229.6	12.1	219.8	3
Motor cars	14,000+	17,500+	379.0	400.0	21.0	383.0	1
Home accidents	11,491	13,641	169.4	204.8	35.4	171.5	4
Alcohol	10,432	27,798	159.5	367.0	207.5	163.2	5
Heroin	9,808	21,927	119.1	263.6	144.5	121.7	7
Home accidents involving electric power	4,032	13,153	70.0	166.9	96.6	71.7	9
Aircraft	3,324	8,296	157.4	248.5	91.1	159.9	6
Pesticides	1,078	10,125	37.9	149.6	111.7	39.4	10
Coal	802	14,189	30.7	178.4	147.7	32.5	11
Nuclear power stations	285	672,423	42.2	6971	6928.8	111.9	8
X-rays	193	2,256	3.1	27.8	24.7	3.3	13
Skiing	130	4,258	18.1	55.8	37.7	18.7	2

+ figures given to the interview subjects

If the different spreads are incorporated and a mixed logarithmic-linear correlation is used, the relation between the two median classes will rise to a value of 0.87.

- Comparison between the computed statistical data for a catastrophic year and the corresponding subjective estimates reveals a greater difference between the two classes of variables. Apparently, most risks are given a relatively similar estimate, since ten of the thirteen risk sources are located within a narrow range between values 6 and 8, while the real values show a dispersion between 2 and 10 (logarithmic scale). Therefore, in a normal year it appears that "common sense" can produce a relatively good estimate of losses. However, where intuitive yardsticks do not exist, which applies to the classification of catastrophic developments, relatively constant loss rates are stated without more detailed differentiation between risk types, or extreme orders of magnitude are selected. As a result, the correlation coefficient between real and perceived values is only 0.39 in this case; the relation is not significant ($p = 0.10$).

If we start out from the result that the risk level and its probability is perceived relatively correctly by the population for an average year, the question immediately arises whether these perceived parameters also determine the subjective evaluation of the risk source. And here a surprising result is obtained. Almost all correlation analyses made between risk estimates and information on future procedure with respect to risk on the one hand and all the possible loss indices on the other hand practically fail to reveal any relationship. Regardless of whether we start out from the perceived number of deaths, injured or property damaged, regardless of whether we construct several indices of these three parameters, whether we divide the risk level by the number of potentially affected persons, whether we use the data for normal or catastrophic years, whether we average the data for normal or catastrophic years under several different procedures (using ratios of 1:50, 1:100 or 1:250) - it is impossible to find a clear-cut relationship to risk-benefit evaluation.

The same result has been found in the American studies. Similar to the present study, these investigators found a very low agreement between estimated risk level and risk evaluation. However, the correlation improved significantly when the data for estimating the catastrophic year were included (Slovic et al, '79, 372, p. 13 ff.). For the German sample even this relationship is not significant.

Several studies on the acceptance of medical risks have arrived at the same conclusion. The acceptance problem is only slightly influenced by the estimate of the risk level but predominantly by the evaluation of risk consequences and the motivations for risk acceptance (Pochin, '75, 317, p. 189).

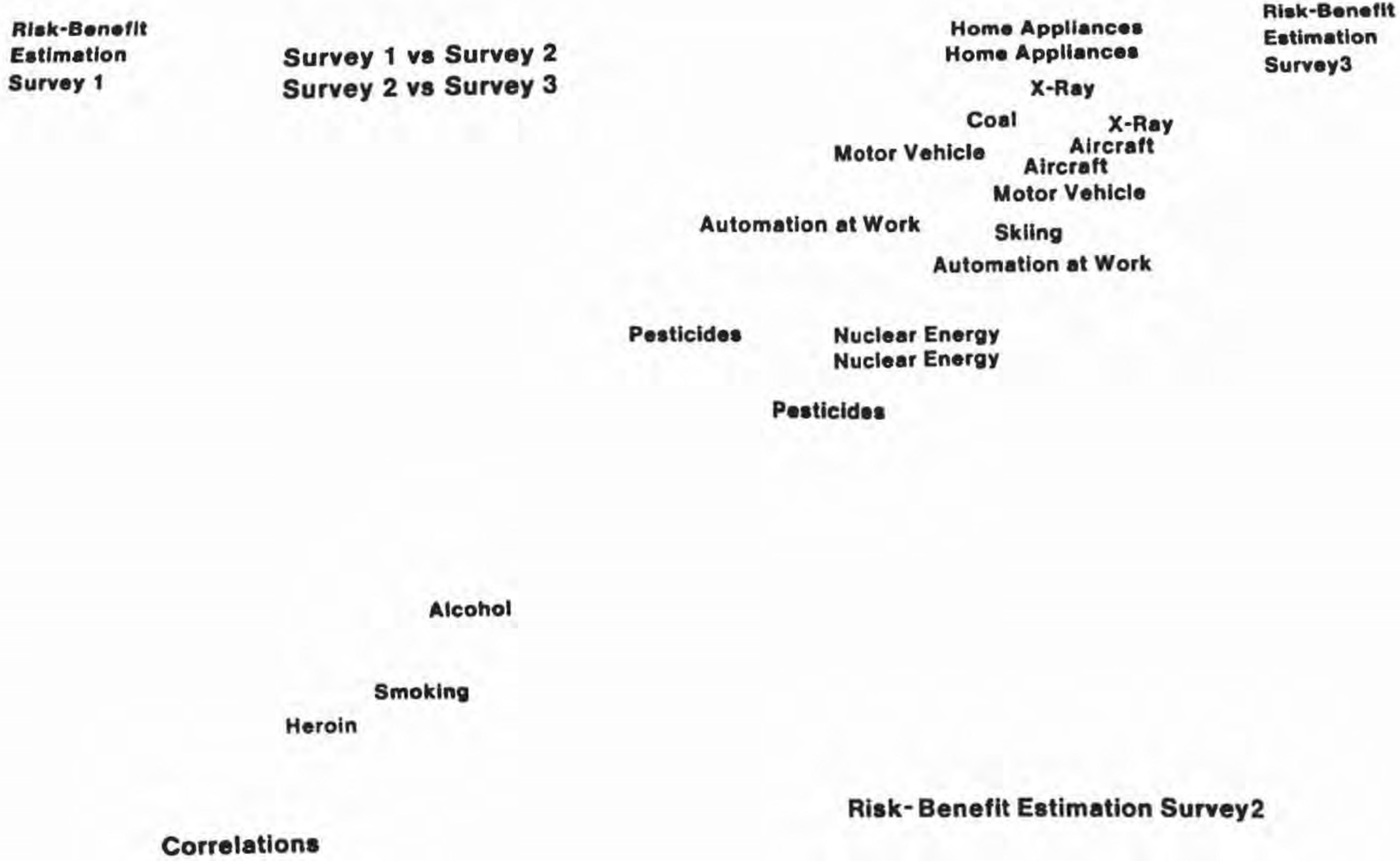
All of these studies confirm the result that the perceived risk levels represent only one, possibly low, influencing factor in the estimation of risk sources. At normal averages the risk level estimates of experts and laymen are relatively homogeneous. However, the experts consider these estimates to be a normative basis for the acceptance decision (this has been confirmed empirically through a survey of experts conducted by Slovic et al, '79, 372, p. 12), while laymen consider it to be only one weighting factor among many.

Homogeneity of Risk-Benefit Estimates Made by Different Population Groups

Prior to discussing the natural question as to the causes of the deviation of the intuitive risk-benefit estimates from the level of the perceived loss rate, a brief explanation of the structure of risk-benefit estimates is of special significance. In all three surveys the interview subjects were requested to state a value on a scale from -3 to +3 which in their opinion best represented the ratio of benefit to detriment for the risk source in question. This variable is referred to as risk-benefit estimate below. In addition, the interview subjects were requested in questionnaire II to grade benefits and detriments separately on a scale from 0 to 10. Another index for the risk-benefit estimate was obtained from these two variables by summation. Consequently, the following variables were available for the comparative study of independent and dependent measured values on risk-benefit estimation:

- estimate 1: risk-benefit estimate for 100 interview subjects using questionnaire 1;
- estimate 2: risk-benefit estimate for 100 interview subjects using questionnaire 2;
- estimate 3: medians of the difference between the separately determined benefit and detriment estimate (questionnaire 2);
- estimate 4: risk-benefit estimate for 507 interview subjects using questionnaire 3.

The distribution of the medians for each of these four estimates has been plotted in Figure 15. Good agreement between the medians is seen at first glance. This is


Risk-Benefit
Estimation
Survey 1
Survey 1 vs Survey 2
Survey 2 vs Survey 3
Home Appliances
Home Appliances
Risk-Benefit
Estimation
Survey3
X-Ray
Coal
X-Ray
Aircraft
Motor Vehicle
Aircraft
Motor Vehicle
Automation at Work
Skiing
Automation at Work
Pesticides
Nuclear Energy
Nuclear Energy
Pesticides
Alcohol
Smoking
Heroin
Risk-Benefit Estimation Survey2
Correlations

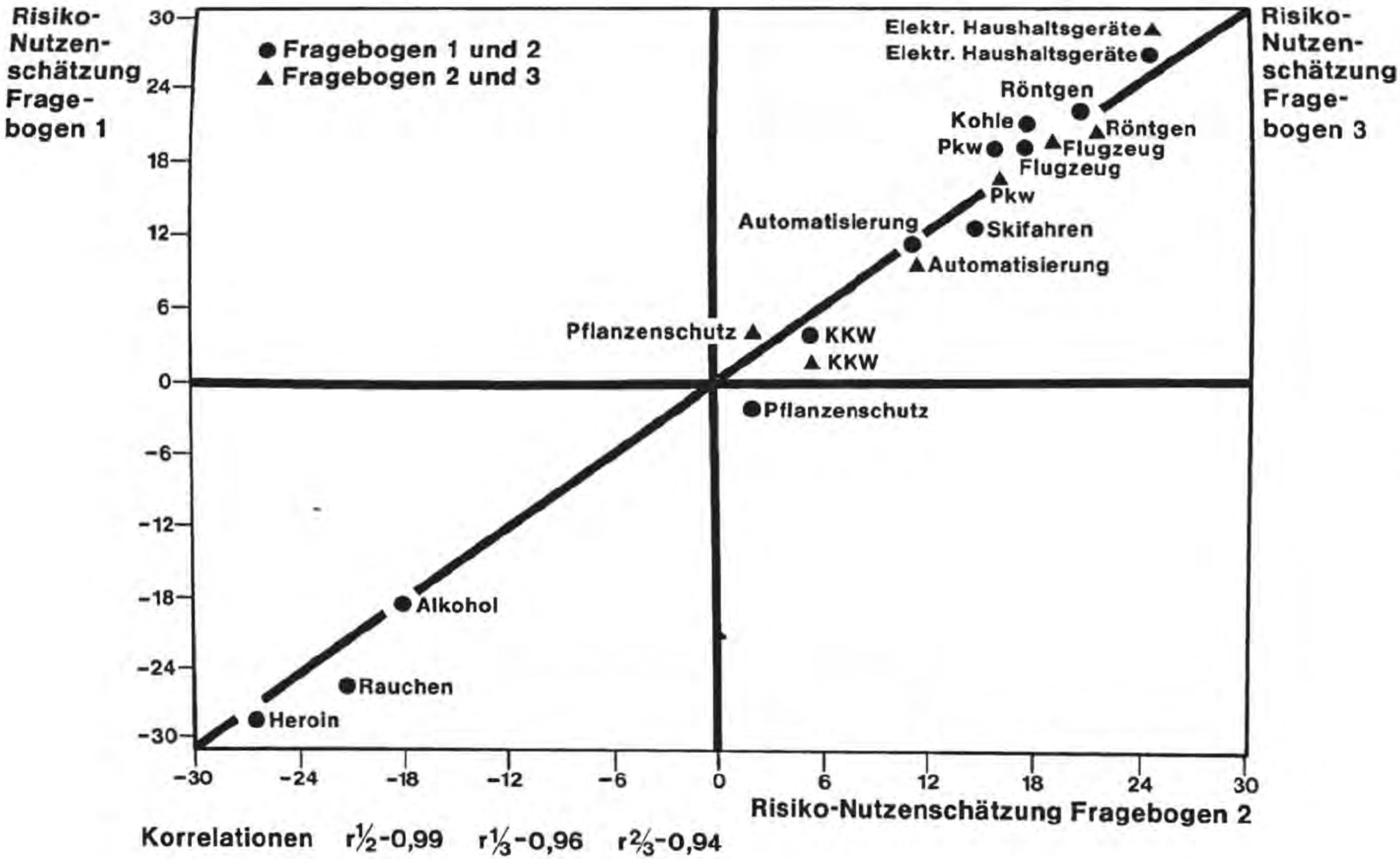


Fig. 14: Mean Values of Three Independently Measured Risk-Benefit Estimations

a striking result, considering that it involved three completely different samples.

The same result is also obtained after differentiating by survey locations. With the exception of the nuclear energy variable, there are no significant differences in risk estimation between interview subjects living in Jülich and in Kerpen. This applies equally to the first and the second questionnaire.

The dispersion spread of the individual categories is also relatively low. This homogeneity of the response behaviour is retained as a basic structure even in the case of highly different criteria differentiation. Apparently the evaluation patterns of individuals are similar - at least for the 13 risk sources included in these studies. This fact allows two conclusions:

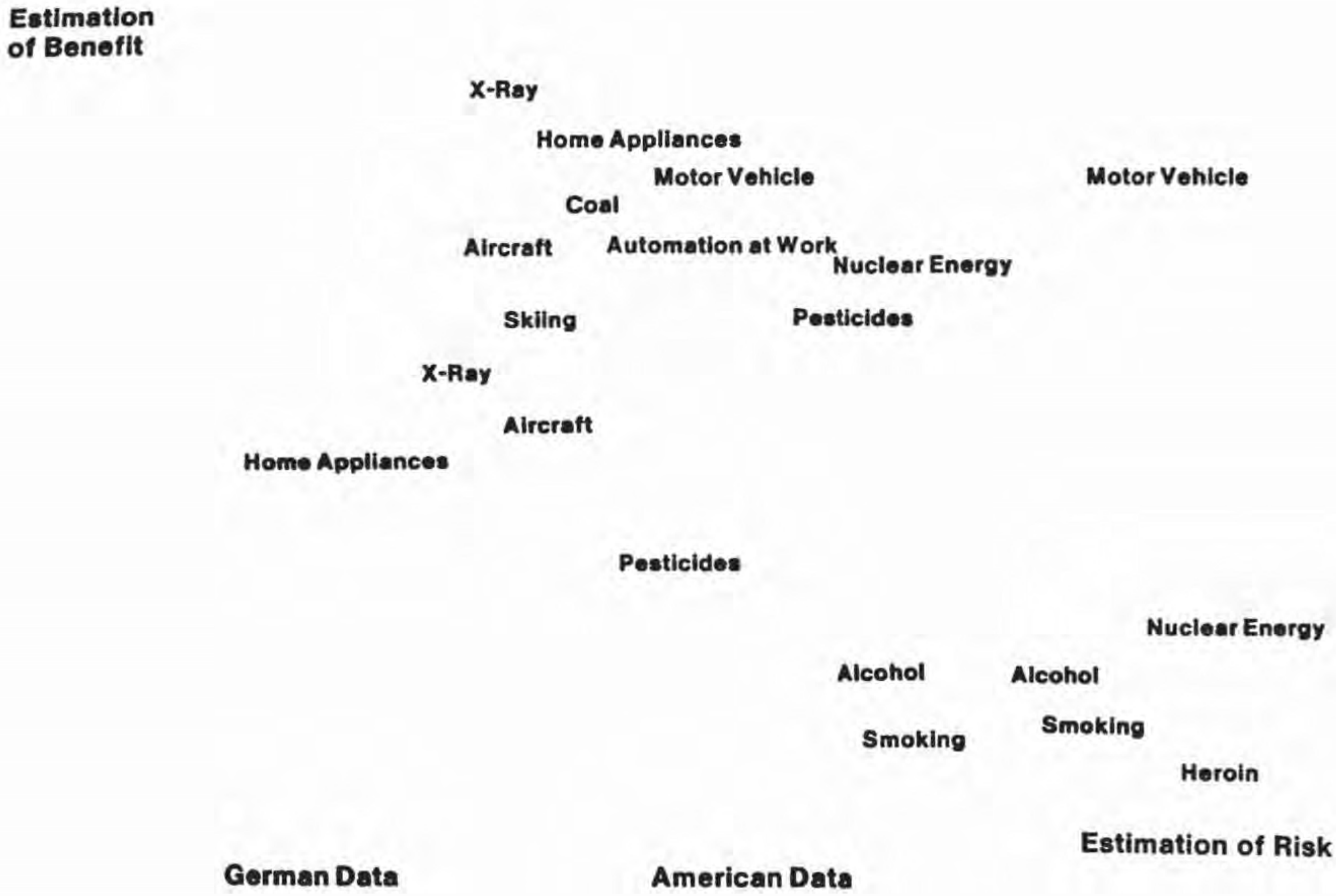
- Risk-benefit estimates of different risk sources follow a relatively rigid judgement pattern in the case of all individuals.

- The results of this judgement process agree to a large degree so that it is probable that the determinants of this process have similar interpersonal structures.

With respect to the question regarding the future procedure to be adopted for risk-handling, the uniformity of response behaviour is less pronounced between questionnaires 1 and 2. The correlation coefficients for the 13 risk sources vary from 0.13 (motor car) to 0.77 (heroin). This may be due, on the one hand, to the fact that the individual questions as well as the response categories were phrased differently. On the other hand, it is also possible that risk level and benefit receive the same interpersonal estimate, but that this does not apply to the desired consequences.

If we use the separate estimates of benefits and detriments as a basis for analysis, we encounter a reciprocal relationship: the greater the benefit estimate, the lower will be the estimate of the detrimental effects. Both quantities correlate at an intensity of -0.96. This result is contrary to the values obtained in the Fischhoff study ('78, 114, p. 132 ff.) and an IAEA study by Otway ('77, 297, p. 15) where benefit and detriment were given different weights for overall judgement. However, different methodologies were used for these two studies.

In spite of this discrepancy, a glance at Figure 15 reveals that, considering the point aggregation, the American values reported by Fischhoff have a structure which is highly similar to that of the German values. On the whole there is merely a parallel shift toward the left-hand bottom corner. This may be due to the linear transposition of the American data into the existing coordinate system or to the use of a different measuring technique. For Fischhoff et al divided their test subjects into two groups, one of which evaluated only the benefits and the other only the risks. Yet there is great agreement: both the relative spacing of the points and their distance from the respective regression line are almost identical. This observation once again supports the thesis of a relatively universal estimation of risk and benefit levels of known risk sources.


Estimation of Benefit
X-Ray
Home Appliances
Motor Vehicle
Motor Vehicle
Coal
Aircraft
Automation at Work
Nuclear Energy
Skiing
Pesticides
X-Ray
Aircraft
Home Appliances
Pesticides
Nuclear Energy
Alcohol
Alcohol
Smoking
Smoking
Heroin
Estimation of Risk
German Data
American Data

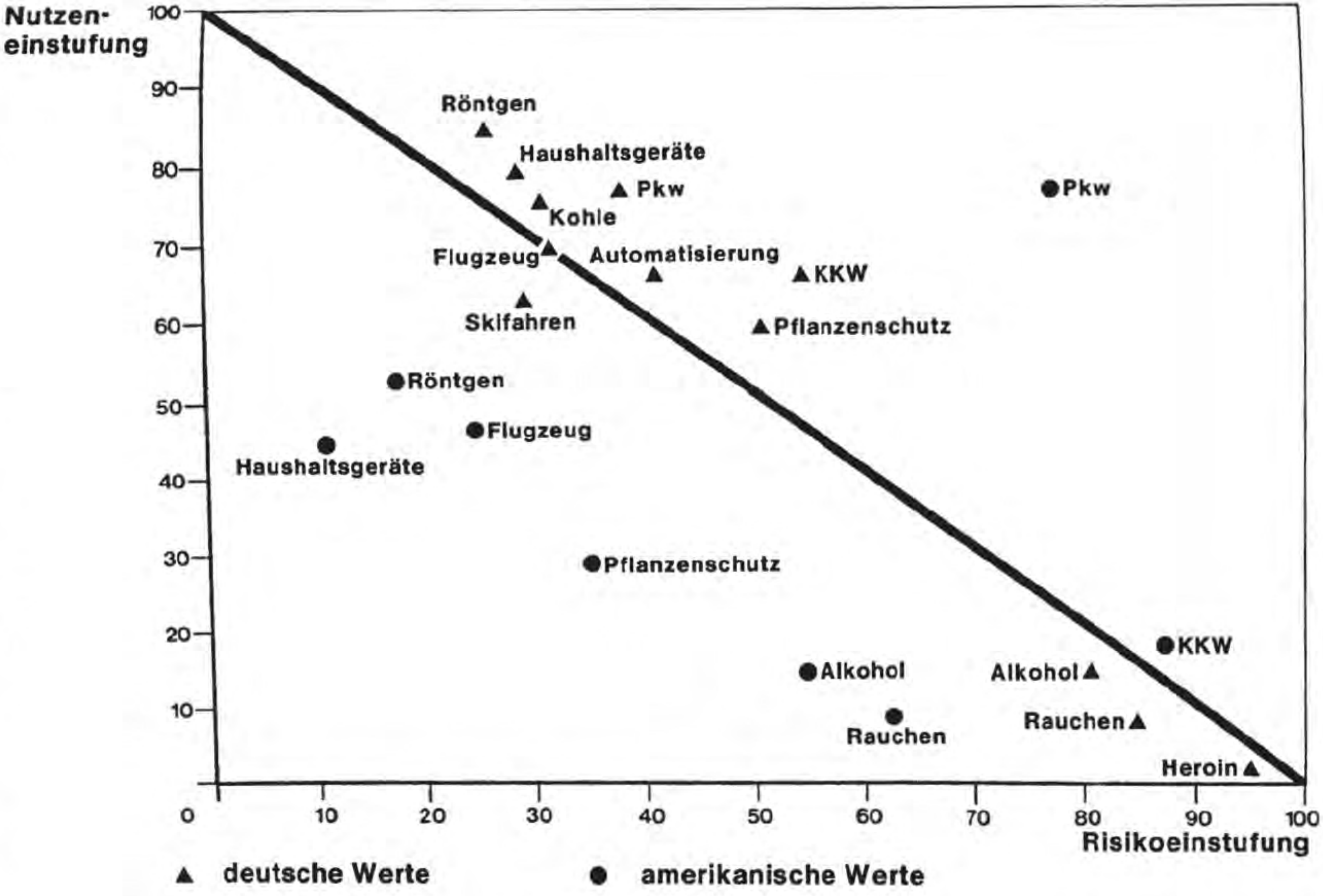


Fig. 15: The Estimation of Benefit and Risk - A Comparison between German and American Data

Effect of Ideas on the Characteristics of the Individual Risk Sources (Belief System)

Two important results of the risk perception analysis must be retained so far:

- Risk estimation is only slightly dependent on the perceived loss rate per unit of time.

- The evaluation of risk sources on the basis of their intuitive benefit-detriment distribution or risk-benefit estimate is relatively universal for all the interview subjects.

The present chapter is concerned with describing a class of variables which might provide an explanation of the level and uniformity of risk-benefit estimates of different risk sources: the subjective ideas and arguments given for each risk source (the so-called belief system). For this purpose, a special scale including 46 statements on economic, health, personal, society-related and political aspects has been designed, and the interview subjects were requested to state the probability for the occurrence of each of these consequences. Contrary to the otherwise customary scales, positive and negative consequences were measured separately to acquire the ranking of each statement with respect to both content (right or wrong) and direction (encountered more frequently as a negative consequence or encountered more frequently as a positive consequence). Finally, similar to Fischbein's attitude measurement model (where the scale values for the belief system are multiplied by the general subjective evaluation of these statements), the responses to each statement were weighted with the values of the so-called evaluation scale (the personal significance of each argument to the interview subject).

However, due to reasons of methodology, the non-weighted belief scale was used predominantly for evaluation.

Complex statistical techniques had to be used for evaluation of these scales in order to ensure a meaningful and convincing reduction of the total of 1,196 variables to major parameters and factors. For this purpose, three statistical test procedures were used consecutively:

- multiple regression of beliefs, using each risk-benefit estimate and each evaluation index as dependent variables, in order to exclude irrelevant statements;
- factorial analysis of the remaining statements to reveal the basic structure and acquire the major factors;
- variance and regression analyses of these factors, using the risk perception variables which must be explained.

The schematic in Figure 16 shows the results of this evaluation. This graph demonstrates the significance of the individual belief factors for the affective evaluation of each risk source. The evaluation variable for each risk source must be seen separately from the variable of risk-benefit estimation. It was determined as the sum of a so-called semantic differential, a technique which has been tried and tested in the social sciences as a valid instrument for the acquisition of affective representation of objects or groups of persons in one's perceptive images. The numerical data on the ordinate represent the value of the declared variance (R^2) for the dependent variable "risk source evaluation".

A number of interpretation possibilities exist for a comparison of the columns for the 12 risk types. The following relationships appear to have special interest:

- A common characteristic of the positive leaders in risk-benefit evaluation is that subject-related values and advantages play a dominant role (electrical appliances, X-rays, motor car, coal).

- The risk sources given a relatively positive evaluation (intermediate position) are characterized by strong emphasis on benefits to society and to the economy which have only minor effects on the individual (aircraft, automation).

- Risk sources given a highly ambivalent evaluation (nuclear power stations, pesticides) are associated predominantly with socio-political and society-related disadvantages, while health aspects and personal economic advantages are approximately balanced.

- In the case of risks given a clearly negative evaluation (smoking, alcohol, heroin) the aspect of the individual's own health detriment becomes largely dominant. This means that subject-referred values have a strong effect on risk-benefit estimation in both the positive and the negative range. The acceptance of habit-forming products, in particular, appears to be dependent on the ratio of the perceived enjoyment factor to the perceived potential health detriment. While the enjoyment factor of alcohol ranges one percentage point above the health detriment factor, the evaluation is inverted in the case of nicotine, and for heroin the ratio is 1:5. The risk-benefit estimates are given in the same negative sequence. This might be a useful fact, for instance for public information campaigns. Health detriments are perceived for all habit-forming products, but their estimation and acceptance is significantly determined by the ratio of perceived potential enjoyment and believed degree of potential health detriment, regardless of the absolute level of the corresponding values.

- The skiing risk falls slightly out of the general pattern: positive and personal aspects by far predominate, but the risk-benefit estimation occupies a more intermediate position. It is possible that this reflects symbolic beliefs not taken into consideration, such as "skiing is only for the affluent". Last but not least, the behavioural role component (where the interview subjects were skiers themselves) is likely to have a significant effect on the perception of skiing risk.

- Another interesting area is the comparison between the alternatives of coal and nuclear energy. Both have the same purpose, the generation of electric power. However, the perception structure for these two systems differs greatly. Apparently coal is directly associated with electric power supply and hence with quality of life, pleasure and enjoyment, while in the case of nuclear energy the society-related and social constraints appear to be the most important links in the association chain. The perceived personal advantages of coal energy overshadow the also perceived disadvantages to the environment and to health.

  In the case of nuclear energy, health aspects and accident risks are also found as important negative items. Therefore, the predominance of negative

Multiple R^2

Smoking | Alcohol | Heroin | X-Ray | Skiing | Pesticides | Home Appliances | Nuclear Energy | Coal | Motor Vehicle | Aircraft | Automation at Work

Risk Source

1 Personal Health
2 Pleasure and Comfort
3 Social Burden
4 General Health

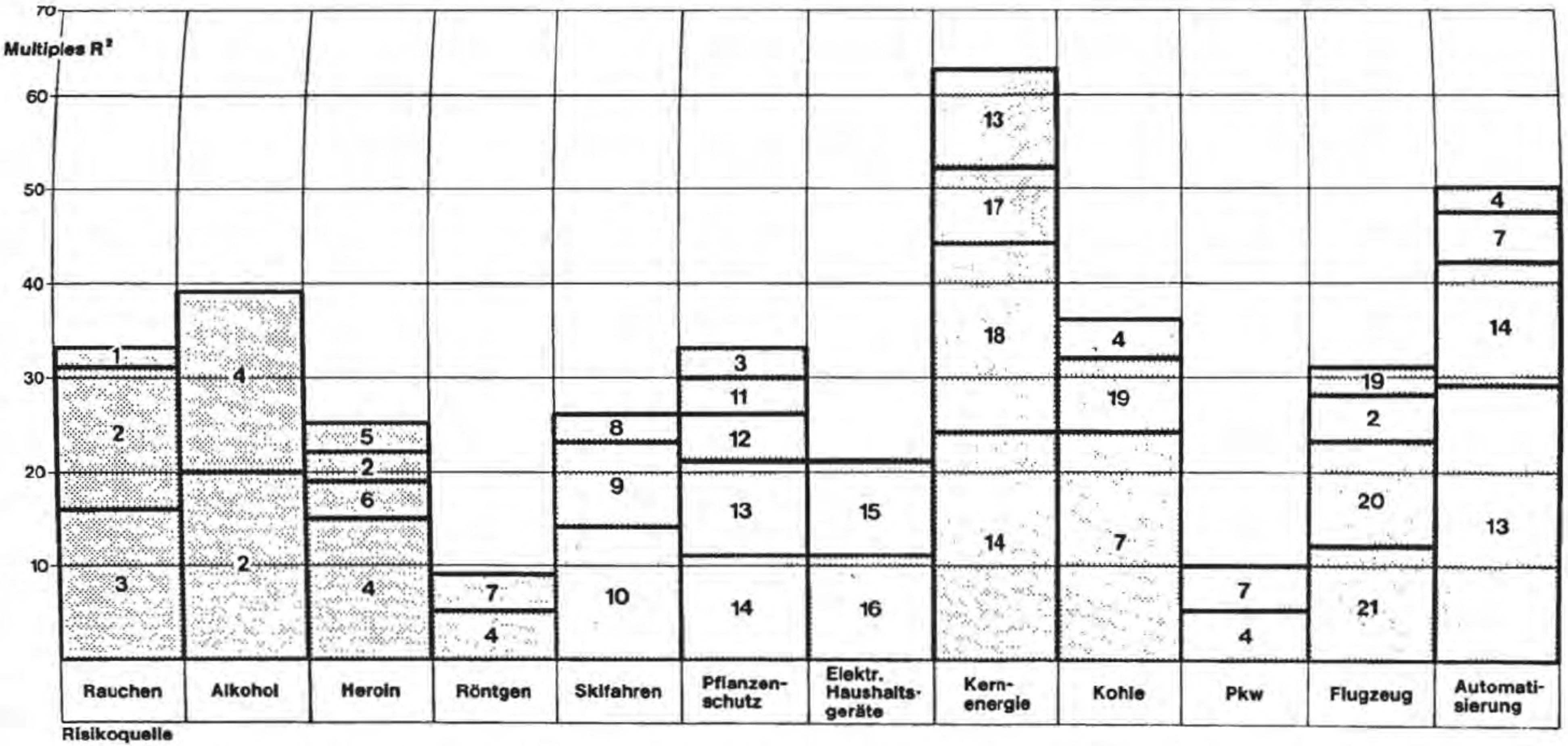
5 Social Retrogression
6 Personal Dependence
7 Personal Advantages
8 Accident Risk

9 Maintenance of Health Condition
10 General Health
11 Personal Disadvantages
12 Environment/Health

13 Economic Advantages
14 Sociopolitical Disadvantages
15 Social Progress
16 Personal and Economic Advantages

17 Future Quality of Life
18 Risk of Life and Limb
19 Environmental Hazards
20 Accident Risk
21 Present-Day and Economic Technology

Fig. 16: Factor-Score Patterns of the Belief-Scale
(Percentage of Declared Variance)



1 Persönliche Gesundheit
2 Genuß u. Bequemlichkeit
3 Soziale Belastung
4 Allgemeine Gesundheit
5 Gesellschaftl. Rückschritt
6 Persönliche Abhängigkeit
7 Persönliche Vorteile
8 Unfall-Risiko
9 Gesundheit und Fitness
10 Allgemeine Gesundheit
11 Persönliche Nachteile
12 Umwelt/Gesundheit
13 Wirtschaftl. Vorteile
14 Soziopolit. Nachteile
15 Gesellschaftl. Fortschritt
16 Persönliche und wirtschaftliche Vorteile
17 Künftige Lebensqualität
18 Gesundheits- und Lebensrisiko
19 Umweltbelastung
20 Unfallrisiko
21 Moderne wirtschaftliche Technik

perception contents may be partly offset by projected expectations in the future and advantages to society and to the economy.

In addition to the individual interview data the medians for each risk source were also analysed as basic data for an aggregate evaluation in order to ensure still better comparability of the risk sources. This procedure was probably used in the study by Fischhoff et al. ('79, 112) but using geometric means, and approximately simulated in the IAEA studies by using three-dimensional factor analysis. However, the following must be kept in mind for this type of aggregate evaluation:

- the greater part of the variance is arbitrarily excluded;

- excessively high coefficients occur in correlation analyses;

- factor analysis will necessarily yield an identical set of factors for each risk source.

Of course, the last-named item describes a desirable result, that, unlike the graph presentation in Figure 16, the information contained in the different scales for each risk source can be combined into absolutely identical factors and that the values in each instance are comparable. However, this is an arbitrary homogenization procedure whose results can be interpreted only with reservations.

This type of factor analysis of the medians yielded the following basic dimensions:

- consequences for the individual (pleasure, happiness, health, leisure, financial losses, convenience, education);

- effects on welfare and society (quality of life, supply, general health, protection of life, standard of living, security, social justice, conservation of the environment);

- social and technological progress or retrogression (modernization, progress of society, advantages to future generations);

- socio-political values (freedom, progress, democratic rights, citizen's participation, social justice);

- direct personal advantages and disadvantages (pleasure, personal advancement, happiness, convenience).

Figures 17a to 17d represent the content structure of the aggregate data. A presentation similar to that of the IAEA study (cf. Page 34) was selected.

The five factors are plotted as block diagrams and, therefore, allow direct visual comparison for each risk source. Again, the three habit-forming products exhibit the sequence of alcohol-smoking-heroin in almost all evaluation aspects. The greatest personal advantages are associated with alcohol, followed by cigarette smoking and heroin. The same applies approximately to the perception of society-related consequences. While the social progress factor has no interpretative significance (as already described in the case of the individual analysis), alcohol and smoking are reversed for the socio-political effects. Although the difference

Alcohol Smoking Heroin

S1 — Personal Direct and Indirect Advantages and Disadvantages

S2 — Effects for the Public and the Society

S3 — Social and Technological Progress (Retrogression)

S4 — Sociopolitical Values

S5 — Personal Convenience and Pleasure

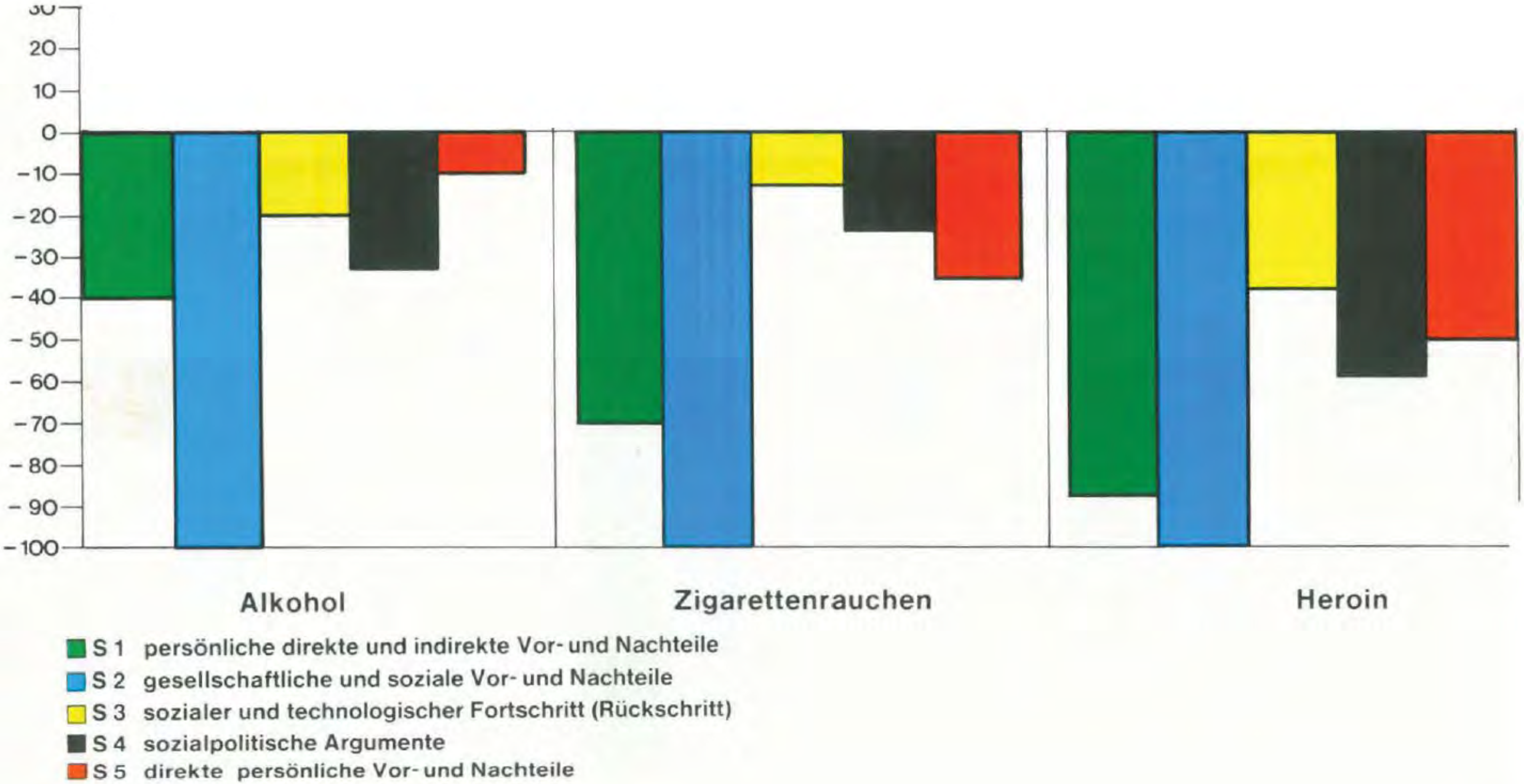
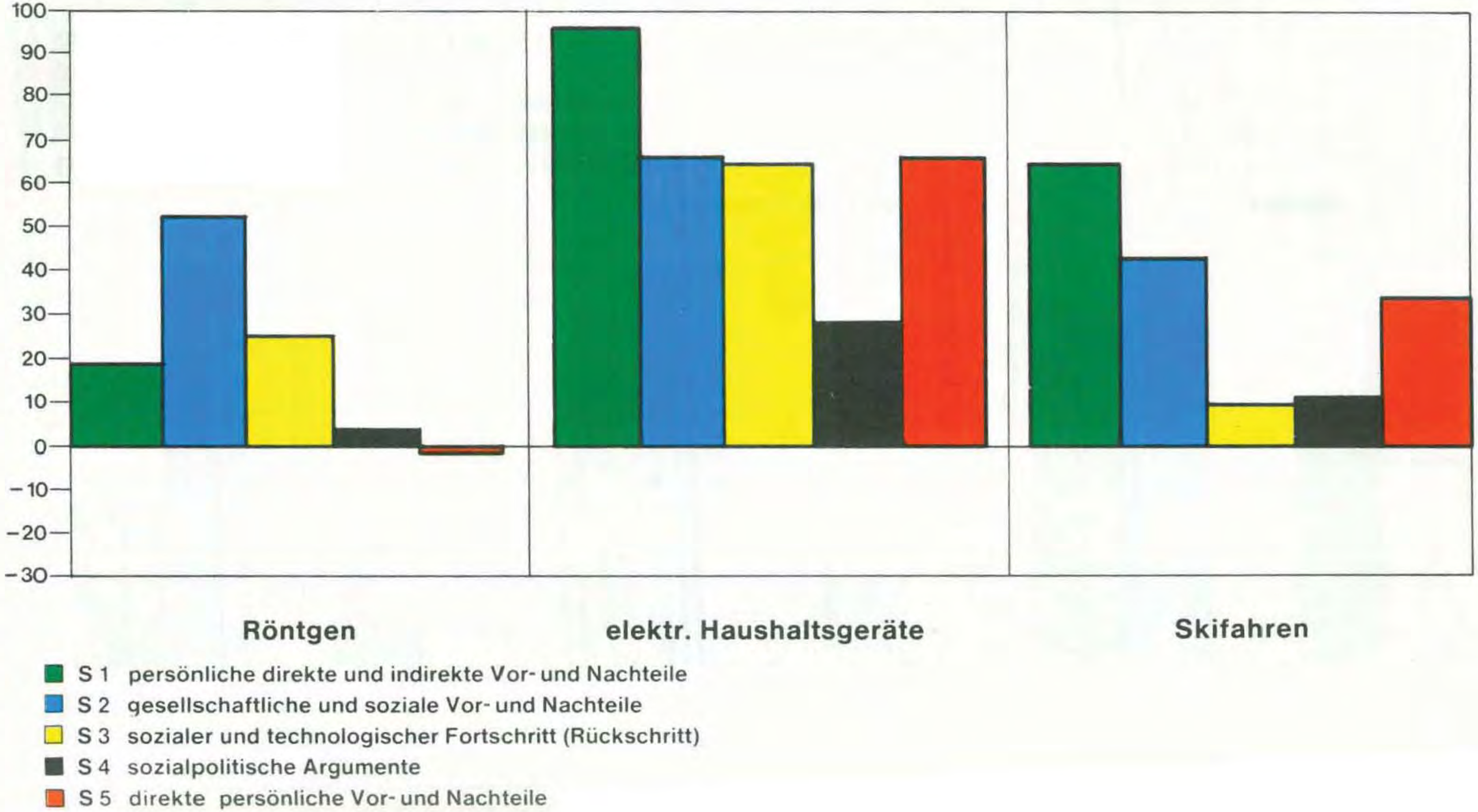


Fig. 17a: Aggregate Belief Structure Factors (Summation of Factorial Loads)

a) Alcohol, Smoking, Heroin

Fig. 17b: Aggregate Belief Structure Factors (Summation of Factorial Loads)

b) X-Rays, Electrical Appliances, Skiing



X-Ray | **Home Appliances** | **Skiing**

S 1 Personal Direct and Indirect Advantages and Disadvantages
S 2 Effects for the Public and the Society
S 3 – Social and Technological Progress (Retrogression)
S 4 – Sociopolitical Values
S 5 – Personal Convenience and Pleasure

Automation at Work	Motor Vehicle	Aircraft

S1 — Personal Direct and Indirect Advantages and Disadvantages
S2 — Effects for the Public and the Society
S3 — Social and Technological Progress (Retrogression)
S4 — Sociopolitical Values
S5 — Personal Convenience and Pleasure

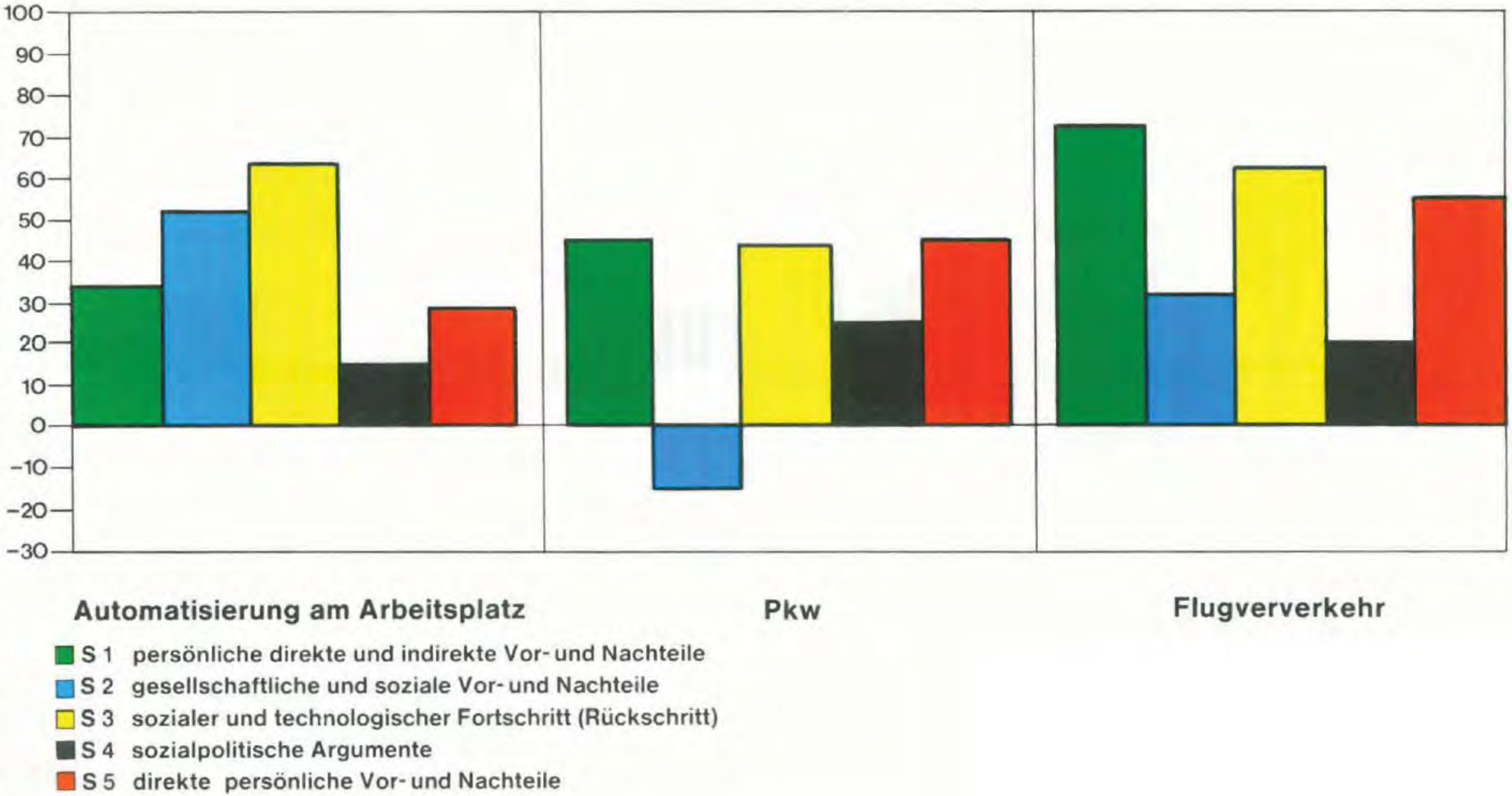


Fig. 17c: Aggregate Belief Structure Factors (Summation of Factorial Loads)
c) Automation, Motor Cars, Air Traffic

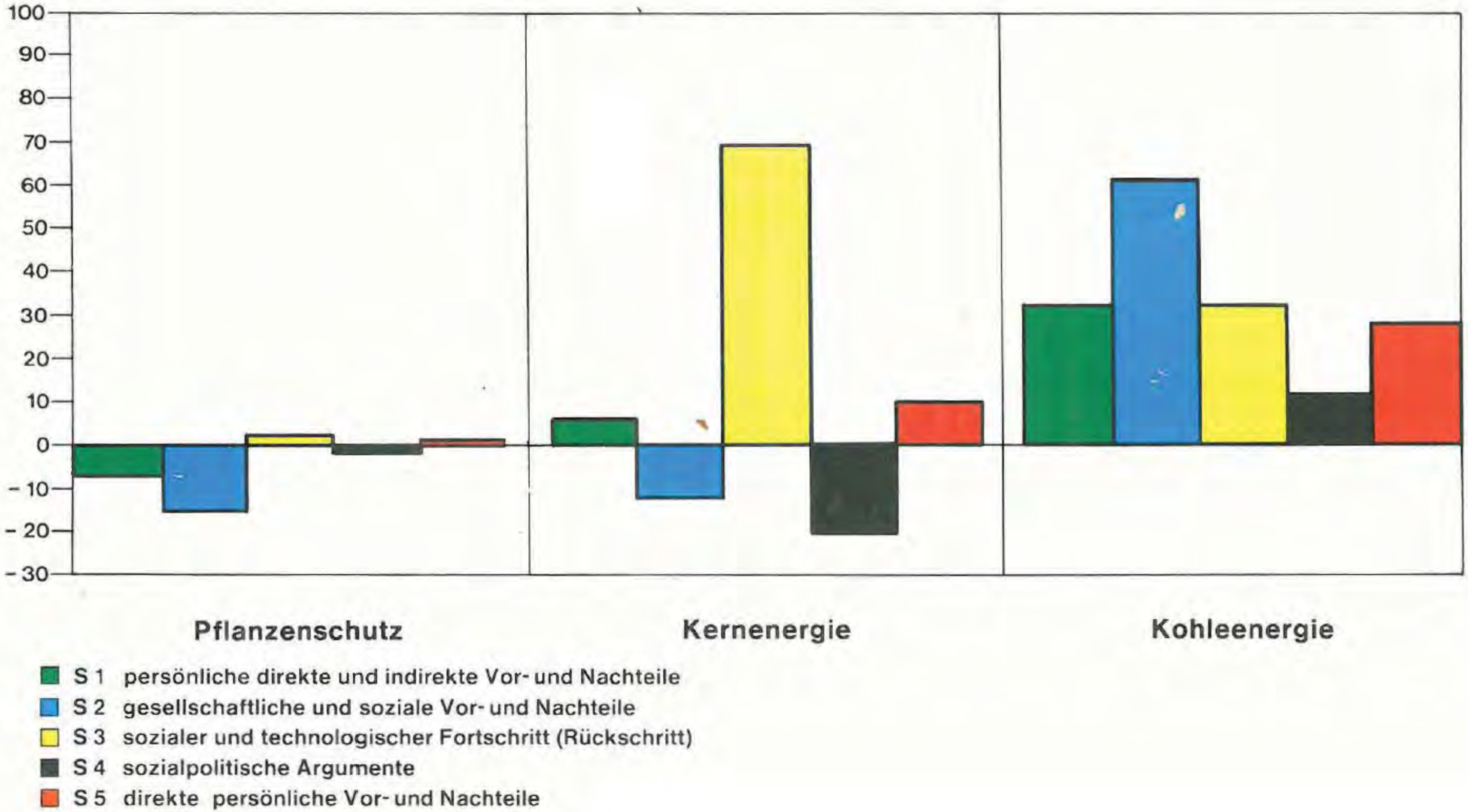


Fig. 17d: Aggregate Belief Structure Factors (Summation of Factorial Loads)
d) Pesticides, Nuclear Energy, Coal

Pesticides **Nuclear Power** **Coal**

S 1 — Personal Direct and Indirect Advantages and Disadvantages
S 2 — Effects for the Public and the Society
S 3 — Social and Technological Progress (Retrogression)
S 4 — Sociopolitical Values
S 5 — Personal Convenience and Pleasure

is minor and, considering the small number of cases, cannot claim any significance, this inversion appears plausible since the consequences of alcohol to health and social life are more easily perceived than the consequences of smoking. In the case of heroin, the most negative beliefs, compared to alcohol and nicotine, are found on all factorial levels.

An especially ambivalent structure of belief factors is found in the case of pesticides and nuclear energy. The balance values for pesticides are clearly distributed about zero, expressing the perceived ambivalence of the advantages and disadvantages of pesticides. The nuclear energy values, on the other hand, exhibit a well-developed high in the question of projected advantages and a well-developed low in the question of consequences to society and politics. On the whole, the subject-related consequences are given a slightly positive evaluation, but not the society-related and economic aspects. These relationships support the theory that, today, the perceived negative consequences of nuclear energy can at best be compensated by its projected advantages.

Using coal energy as a comparison yardstick again, the great difference in the evaluation of personal and society-related aspects is seen at first glance. The median for the subject-related beliefs is 26 points higher for coal than it is for nuclear energy; in the case of the society-related and economic values, the difference is even 68 points. Progress alone, as the third dimension, is attributed more to nuclear energy than it is to coal energy.

Comparison between the two means of transport, motor car and aircraft, reveals some interesting relationships. On the whole, the aircraft has been able to achieve a positive evaluation ahead of the motor car, and air travel was attributed both more subject-related and more society-related advantages. The motor car can acquire a better rating only with respect to "political effects"; this is probably due to the fact that the motor car allows greater expansion of consumer patterns to include all the classes, while the aircraft still suffers a little from the stigma of exclusivity. The differences are significant but yet fairly low.
Another remarkable fact is that the society-related and economic consequences of motor vehicle traffic are perceived to be negative on the average. As perceived by the population, the advantages of motor car traffic such as high standard of living, flexibility and quality of life can no longer offset the high accident rates, congested streets, pollution and over-motorization. However, the percentage of personal advantages is so great that an acceptance crisis in motor car traffic must not be expected. Yet the protest against further development of the highway network and the demands that motor car traffic be reduced which have been put forward recently in Germany appear to have had their effect on general perception by the population.

Electrical home appliances and skiing are given a positive evaluation in all categories where, due to their nature, the factors of progress and socio-political aspects are not very pronounced, especially in the case of skiing as a risk source. The relatively poor rating of X-ray diagnostics as a risk source deviates from the analysis of the individual data. But it is especially here that the imposed factorial structure is likely to have been least justified since, for instance, the factor "direct advantages" is composed primarily of the elements of pleasure, happiness and convenience which have little significance in X-ray diagnostics.

Finally, the surprisingly positive evaluation of the variable "automation on the job" should be pointed out. Positive quantities were obtained for all five factors. Positive beliefs on modern machinery on the job appear to prevail not only with respect to future generations and society as a whole but also for the personal welfare of the individual. Automation in terms of humanizing the job is more deeply rooted in the awareness of the population than the potentially negative effects of unemployment and conditioning by mechanized work.

Effect of Qualitative Risk Characteristics

The psychological literature in the field of risk perception is primarily concerned with the effect of so-called qualitative risk characteristics, i.e. specific characteristics of risk consequences in terms of voluntariness or verification possibilities (cf. Fischhoff et al, '78, 112; Vlek and Stallen, '79, 529; Slovic et al, '78, 368). These inherent characteristics are often considered to be the decisive variables of risk perception. In order to test this theory, a scale of 12 polarity pairs (semantic differential method) was designed which included the following notions:

- voluntary/involuntary;
- useful to all/useful only to some groups of society;
- hazard is directly perceivable/hazard is not perceivable;

- risk is known to science/risk is not known to science;
- immediate detriments/delayed detriments;
- risk can be personally influenced/risk cannot be personally controlled;
- individual has benefits himself/individual has no personal benefits;
- minor consequences in the event of failure/catastrophic consequences in the event of failure;
- known, calculable risk/unknown, incalculable risk;
- every-day risk/entirly unaccustomed risk;
- safety supervised by the public/safety not supervised by the public;
- same benefits can be achieved through alternative facilities of lesser risk/no alternatives exist to achieve the same benefits at lesser risk.

These scalar values were again evaluated statistically and, using multiple regression, compared to the evaluation of each risk source. A graphic review of the results can be seen in Figure 18. The 12 risk sources have been plotted on the abscissa and the value of the relationship on the ordinate (multiple correlation coefficient). Unlike the belief scale, the simple correlation values, not the declared variance, were selected (squared correlation values). For, on the average, the summated proportion of the declared variance is only about 18% while the six factors of the belief scale reached approximately 30 to 38 percentage points. Considering the explanation structure revealed here, the assumption that the qualitative characteristics have a dominant position in risk perception becomes questionable.

Multiple R

Smoking | Heroin | X-Ray | Nuclear Energy | Coal | Automation at Work | Pesticides | Motor Vehicles | Home Appliances

Risk-Object

1 Severe Consequencies
2 Volontary Risk Taking
3 Personal Control
4 Personal Benefit/Risk
5 Hazards Well-Known
6 Available Alternatives with Equal Benefit
7 Everyday Risk
8 Equal Benefit Distribution
9 Safety under Public Control
10 Inperceptible Risk
11 No Personal Control
12 Extraordinary Hazard
13 Involontary Risk
14 Immediate Consequencies
15 Unknown Hazard
16 Minor Consequencies
17 No Available Alternatives with Equal Benefit
18 Delayed (Long-Term) Consequencies
19 Safety under Public Control
20 Technically Advanced

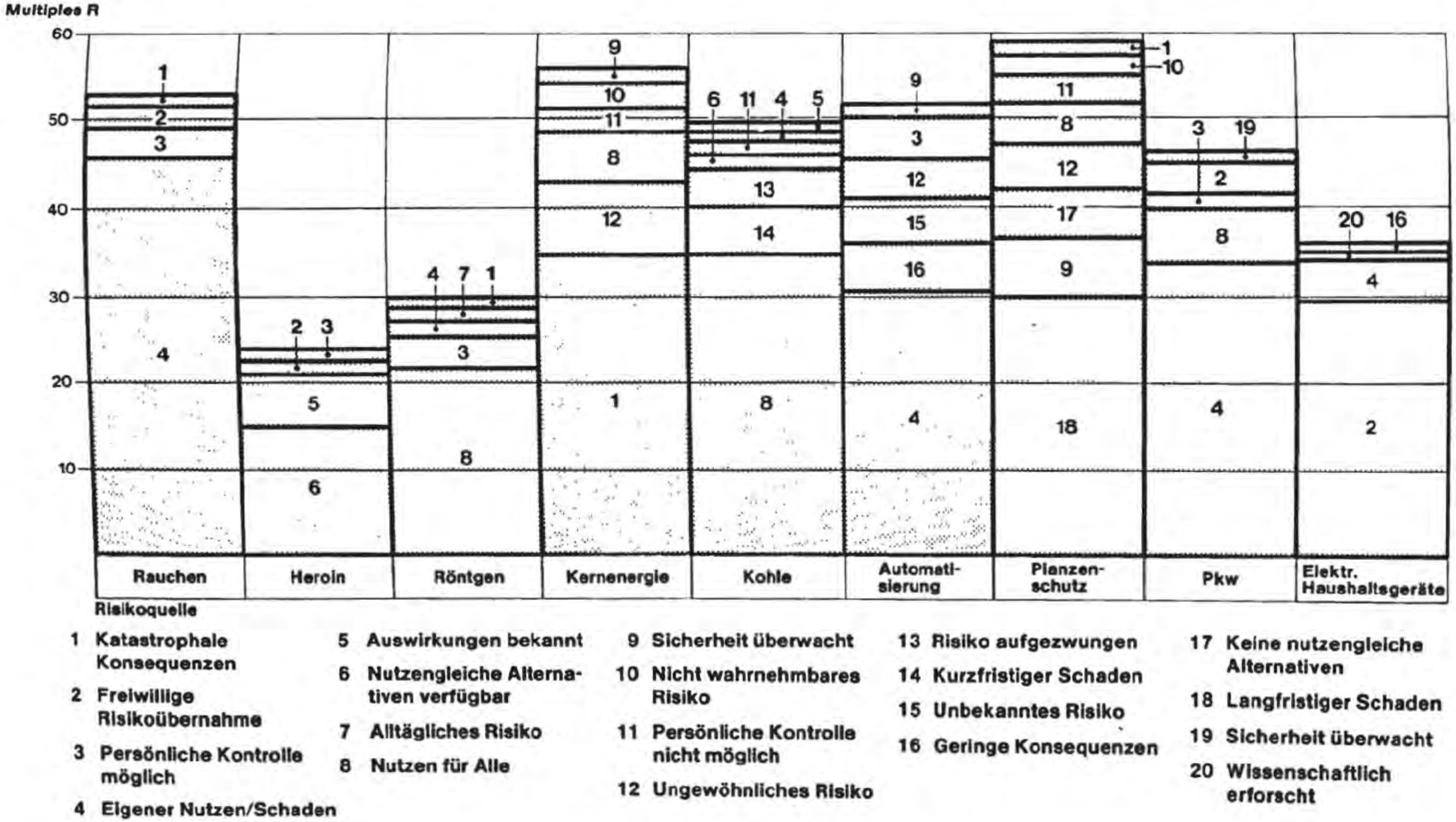


Fig. 18: Factor-Score Patterns of the Qualitative Risk Characteristics: Multiple Regression Coefficients

This assumption becomes all the more questionable because it is the benefit aspects not included by Fischhoff et al which play the most important role in the regression equation for six of the nine risk sources. The risk-related characteristics are closely related only to the extremes "nuclear energy and pesticides" on the one hand and "home appliances" on the other. It is likely that benefit and detriment aspects perceived in risk source evaluation are primary factors in judgement-forming, while qualitative risk characteristics have an effect only where certain risk sources are associated with positive or negative extremes of the qualitative perception. They are used for additional orientation when perception thresholds are exceeded. Similar to the Fischhoff studies, two determining risk areas were developed in this study:

- the voluntariness of risk-taking and the possibility of personal verification;

- the degree and type of potential detriments.

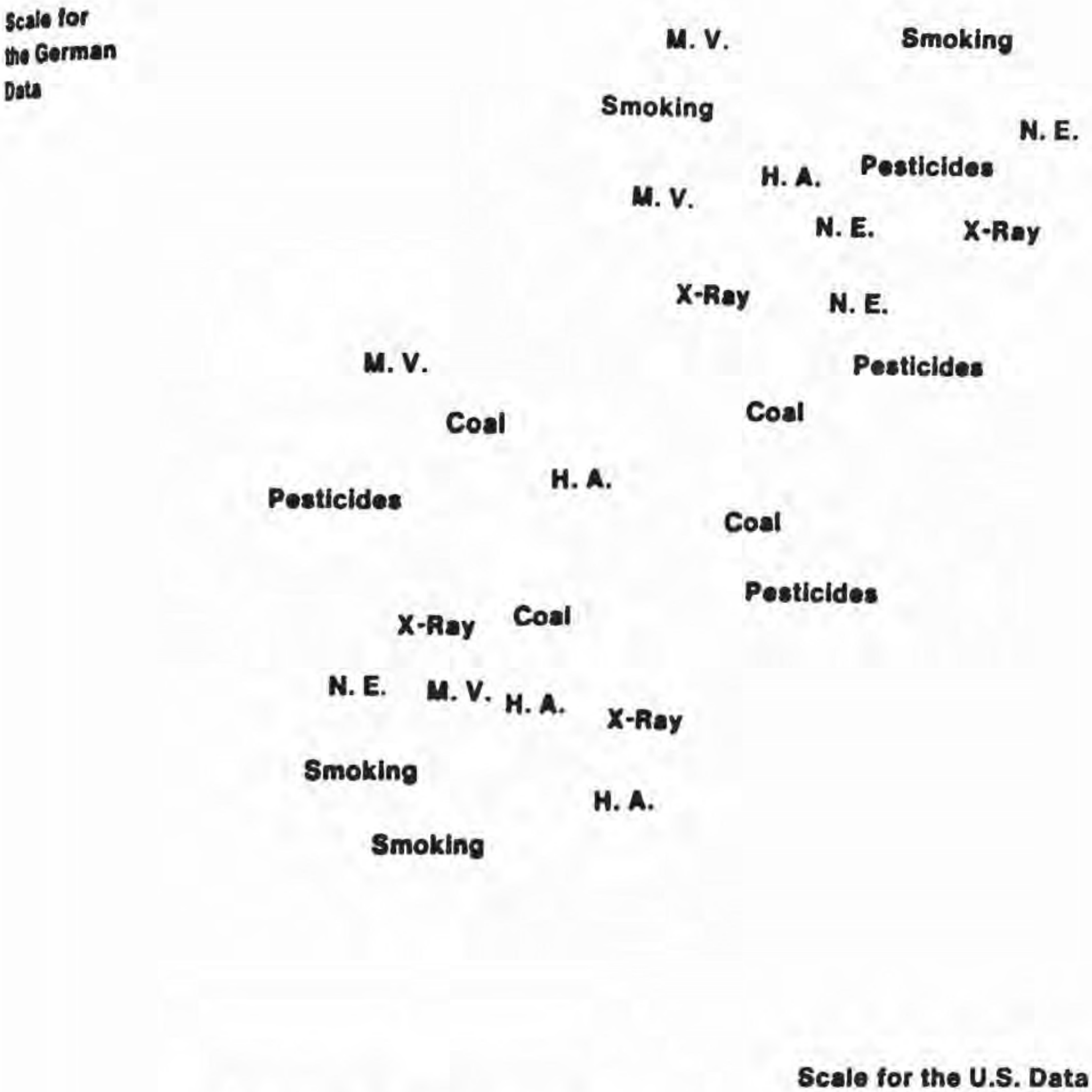
However, the ranking of these two factors must be assessed considerably lower than suggested in the American studies. In order to demonstrate the differences between the two studies, the comparable results from the interviews by Fischhoff et al were transformed in linear fashion to match the German scale, and the different pairs of values were plotted in a coordinate system (cf. Figure 20).

In the four most important criteria, "voluntary, personal verification, scientifically known and immediate effects", over 60% of all values ranged within an interval of ±1 about the median line (uniform distribution). Consequently, the difference in the amount of the explanation value for the qualitative characteristics can hardly be attributed to the different data structure. Rather, it is a product of the aggregate analysis used in the American version which, as described above, inevitably raises the correlation values.

This will become evident immediately when the German data are also aggregated. Comparison of the medians between the qualitative variables and the risk evaluation in each case yields a linear correlation of 0.68 and a curvilinear correlation (exponential curve profile) of 0.74. Figure 20 shows this in graph form.

Using an approach similar to the American study, the aggregate qualitative scale values were subjected to factor analysis. This analysis resulted in three factors: one factor for voluntariness, personal control, public controllability and scientific familiarity, a second factor for the severeness of consequences, everyday nature and short-term effects.
These two factors were also found in the American study (Fischhoff et al, '78, 112, p. 145). A comparison of the individual factor loadings is shown in Table 11. The present study also included the benefit distribution as an additional factor which was not a part of the comparable American study. The absence of this aspect must be interpreted as a deficiency since this dimension covers approximately one third of the explained variance within the scale used here.

The values of the factor loadings were plotted in a coordinate system (Figures 21a to 21c) for better interpretation of the abstract numerical values. In the comparison of factors 1 and 2



Volontary Risk-Taking
Immediate Effect
Personal Control
Known to Science (In German: Technically Advanced)
H. A. Home Appliances
N. E. Nuclear Energy
M. V. Motor Vehicle

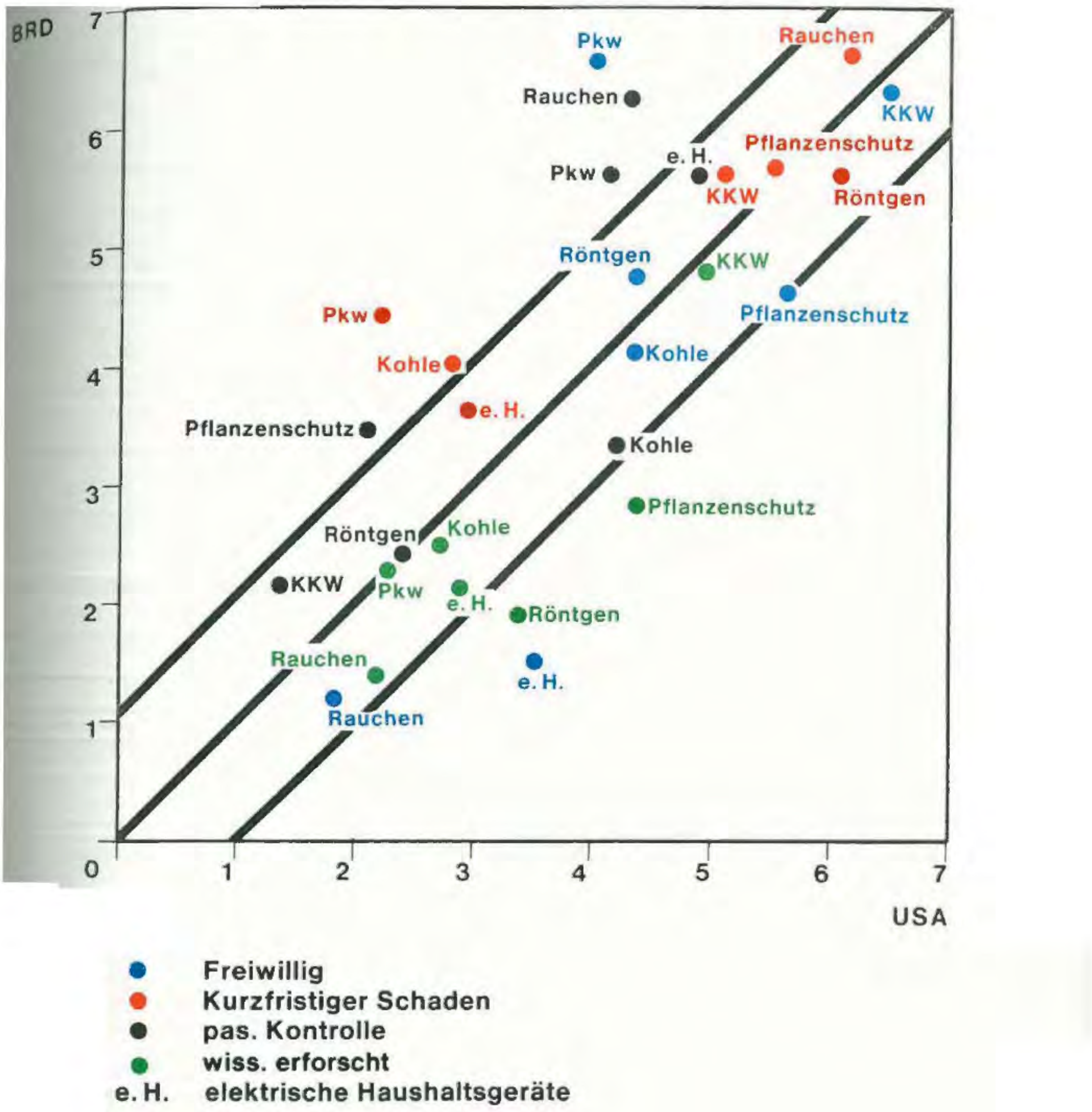
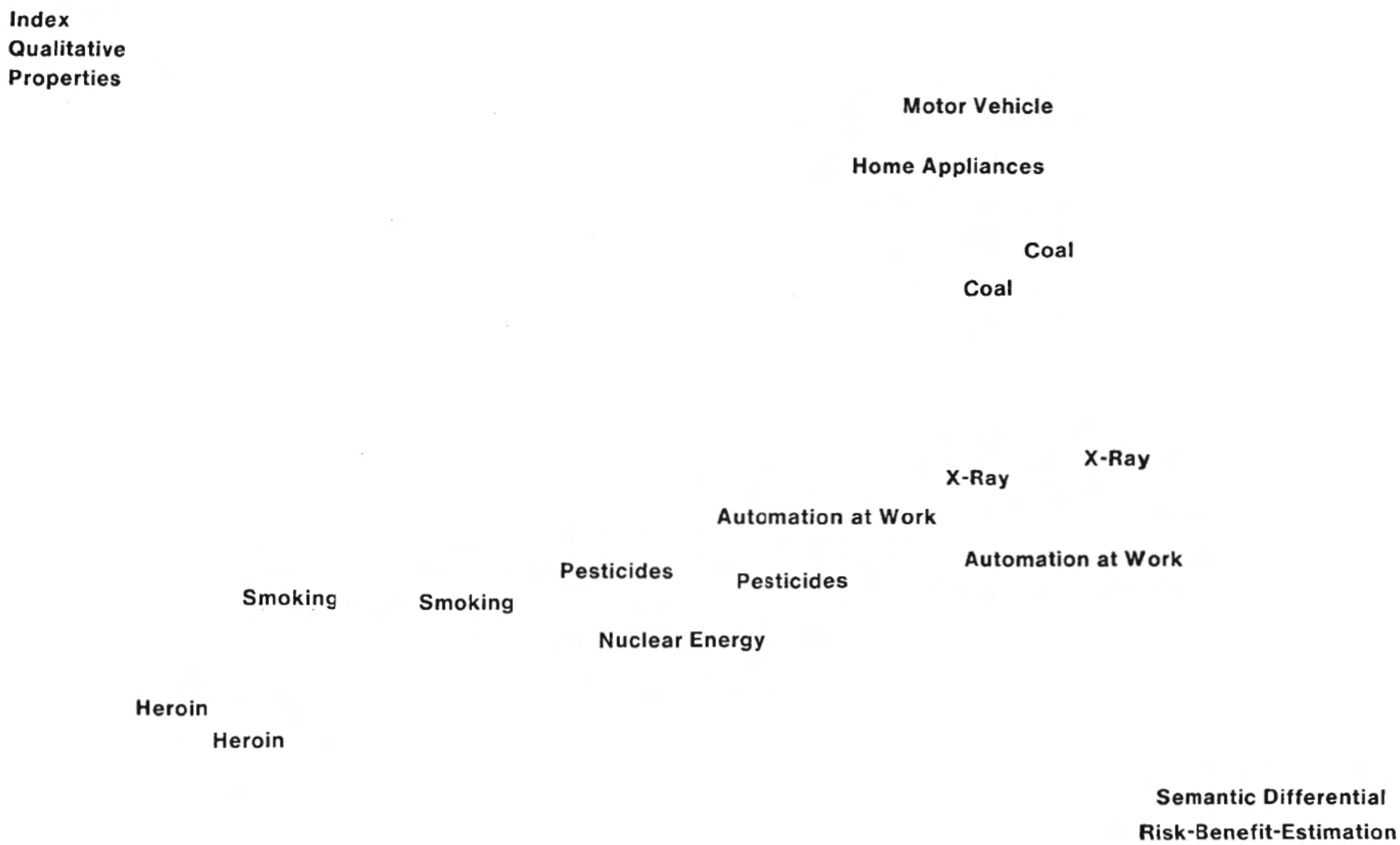


Fig. 19: Comparison of German and American Values for Qualitative Risk Characteristics



Index
Qualitative
Properties
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X-Ray
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Pesticides
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Nuclear Energy
Heroin
Heroin
Semantic Differential
Risk-Benefit-Estimation

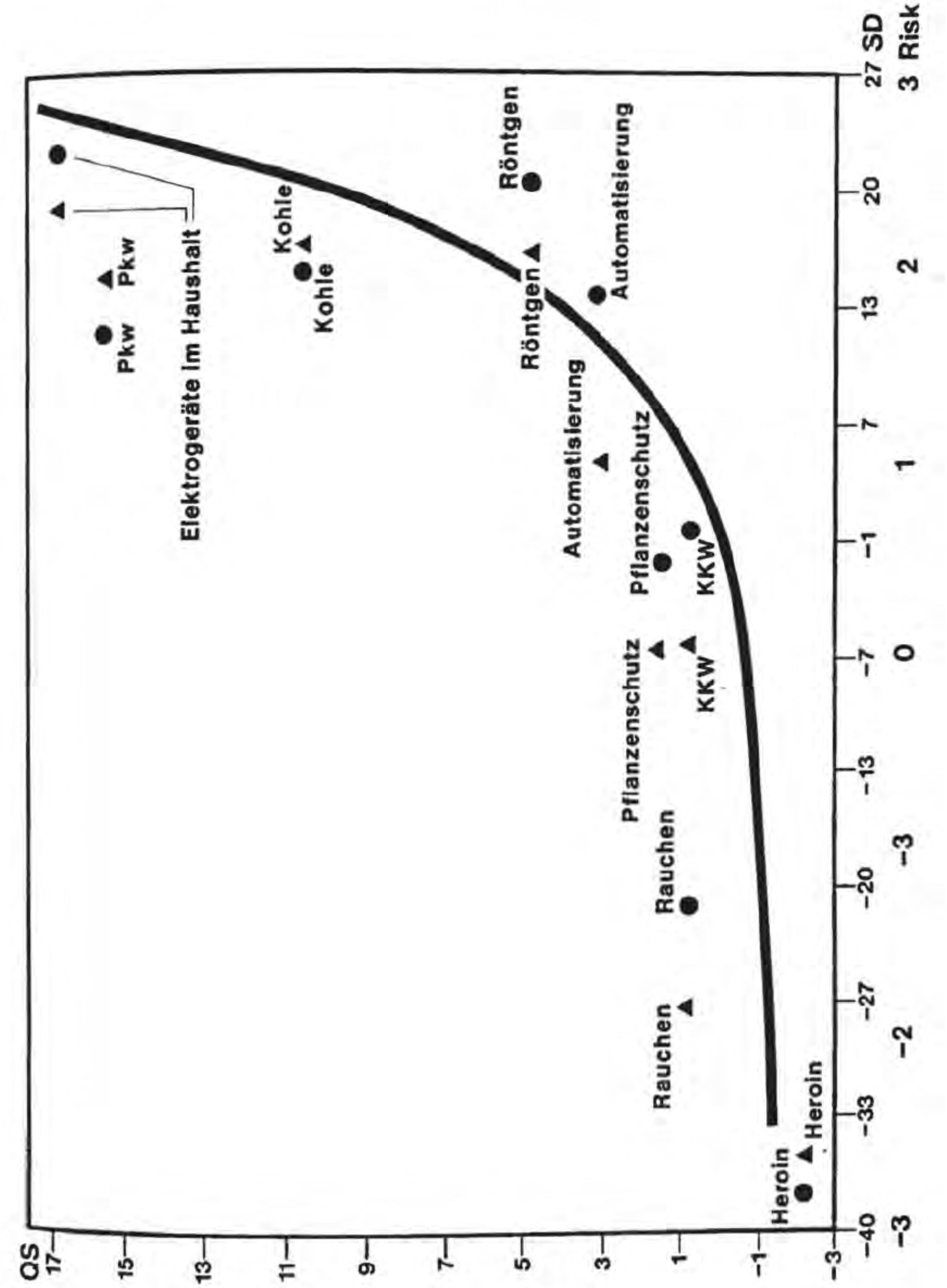


Fig. 20: The Qualitative Risk Characteristics as a Function of Risk-Benefit Estimation and the Risk Evaluation

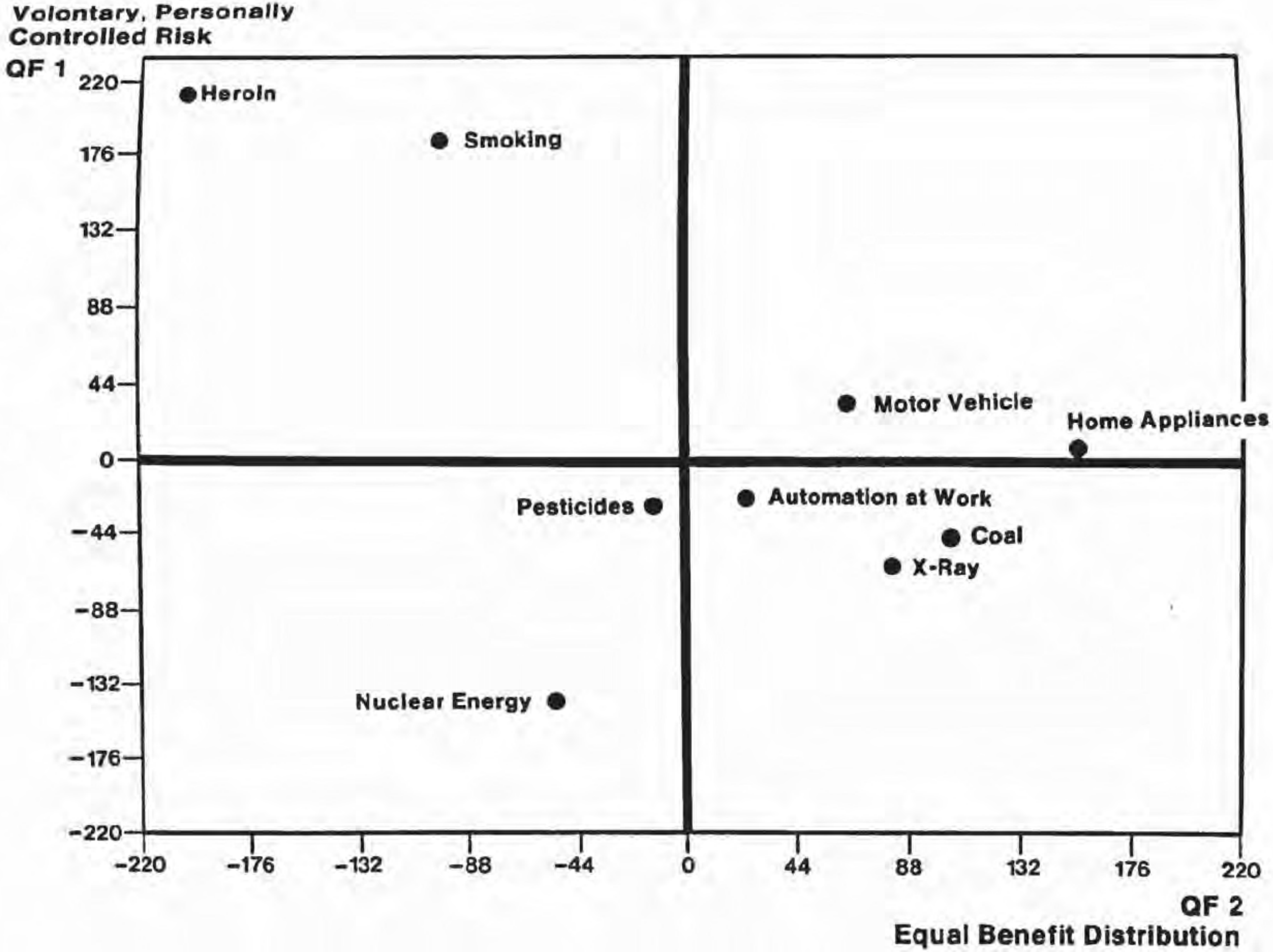
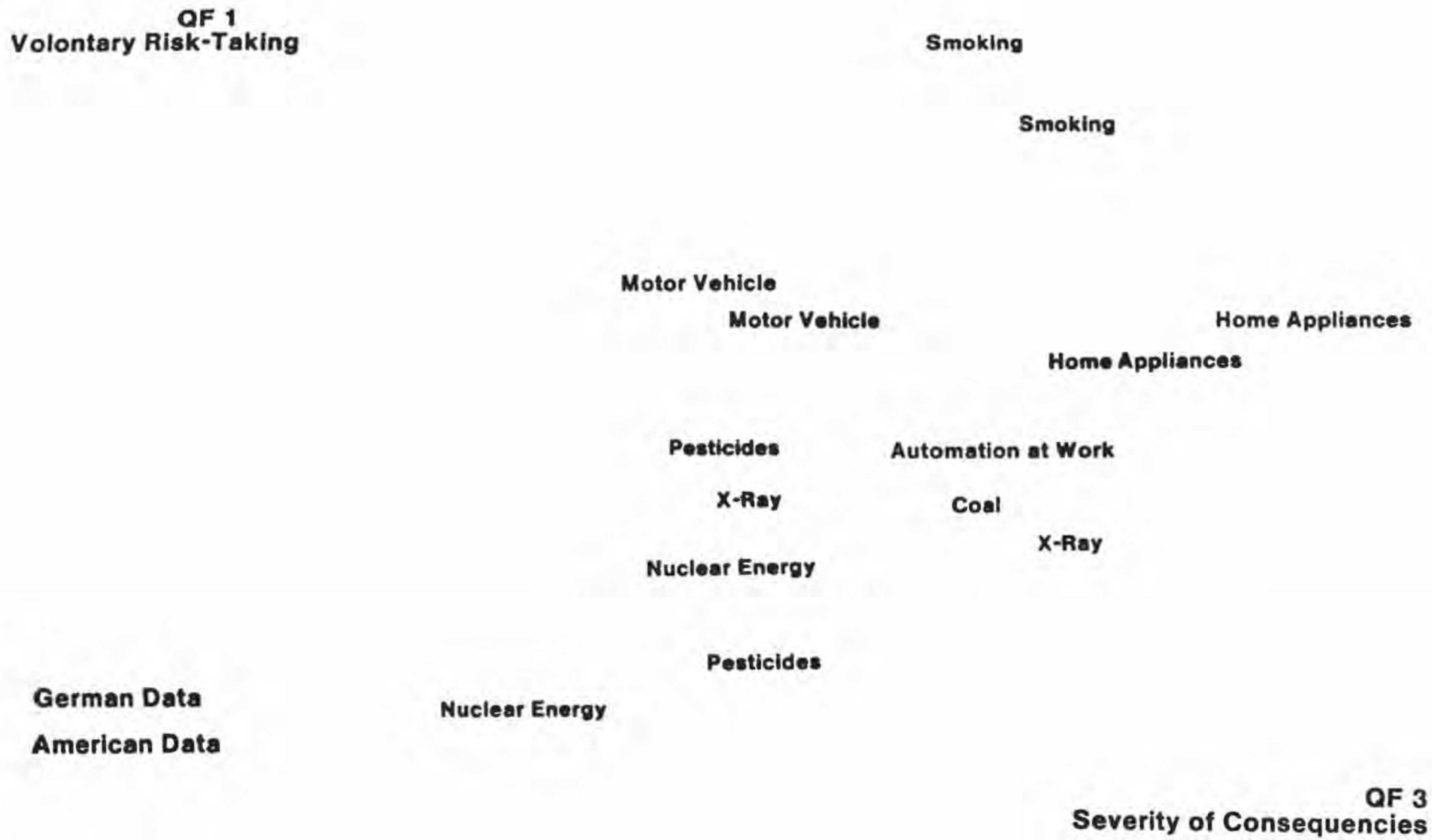


Fig. 21a: Aggregate Qualitative Risk Factors (Voluntariness versus Equal Risk-Benefit Distribution)


QF 1
Volontary Risk-Taking
Smoking
Smoking
Motor Vehicle
Motor Vehicle
Home Appliances
Home Appliances
Pesticides
Automation at Work
X-Ray
Coal
X-Ray
Nuclear Energy
Pesticides
German Data
American Data
Nuclear Energy
QF 3
Severity of Consequencies

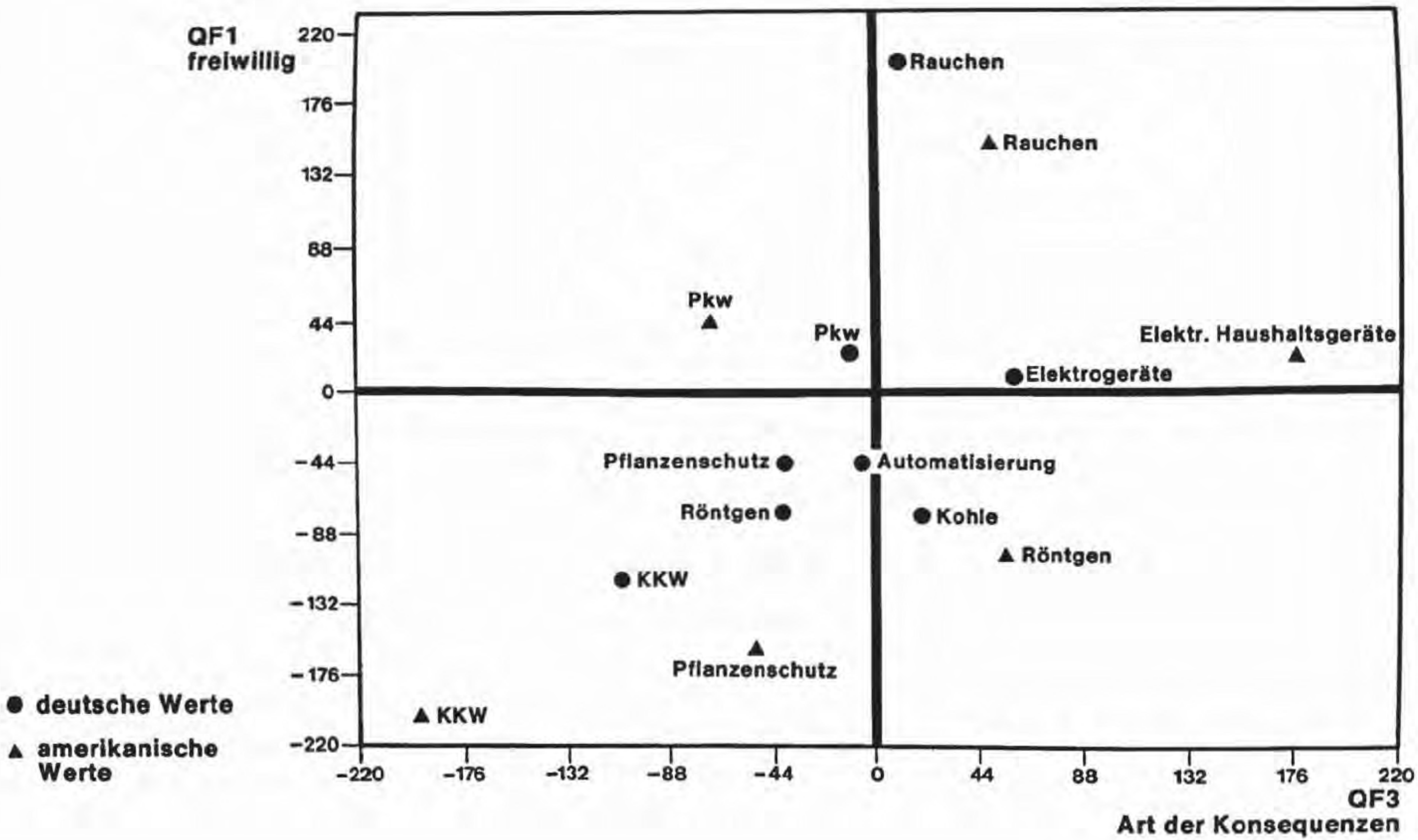
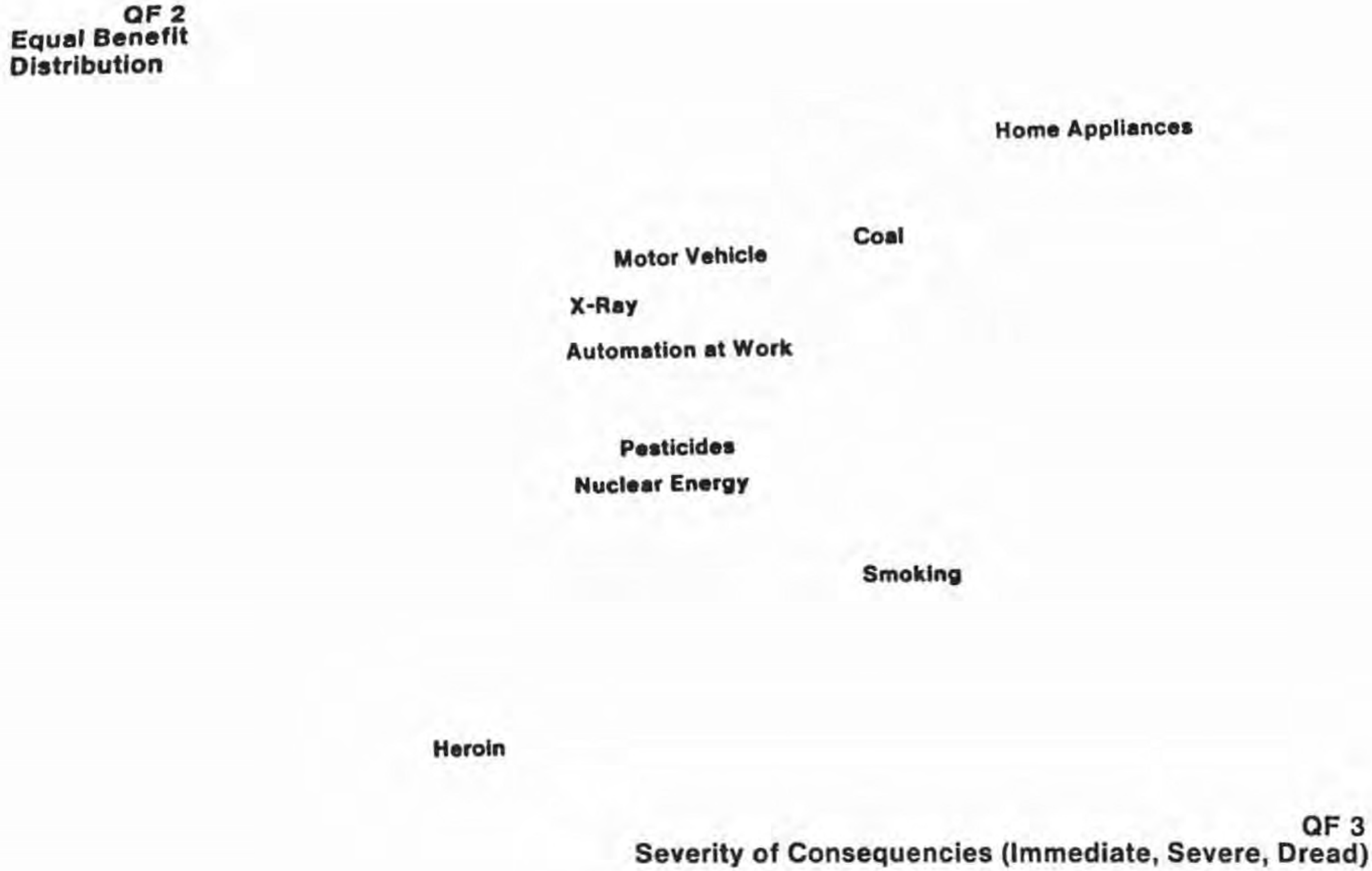


Fig. 21b: Aggregate Qualitative Risk Factors (Voluntariness versus Severeness of Consequences)



QF 2
Equal Benefit
Distribution
Home Appliances
Coal
Motor Vehicle
X-Ray
Automation at Work
Pesticides
Nuclear Energy
Smoking
Heroin
QF 3
Severity of Consequencies (Immediate, Severe, Dread)

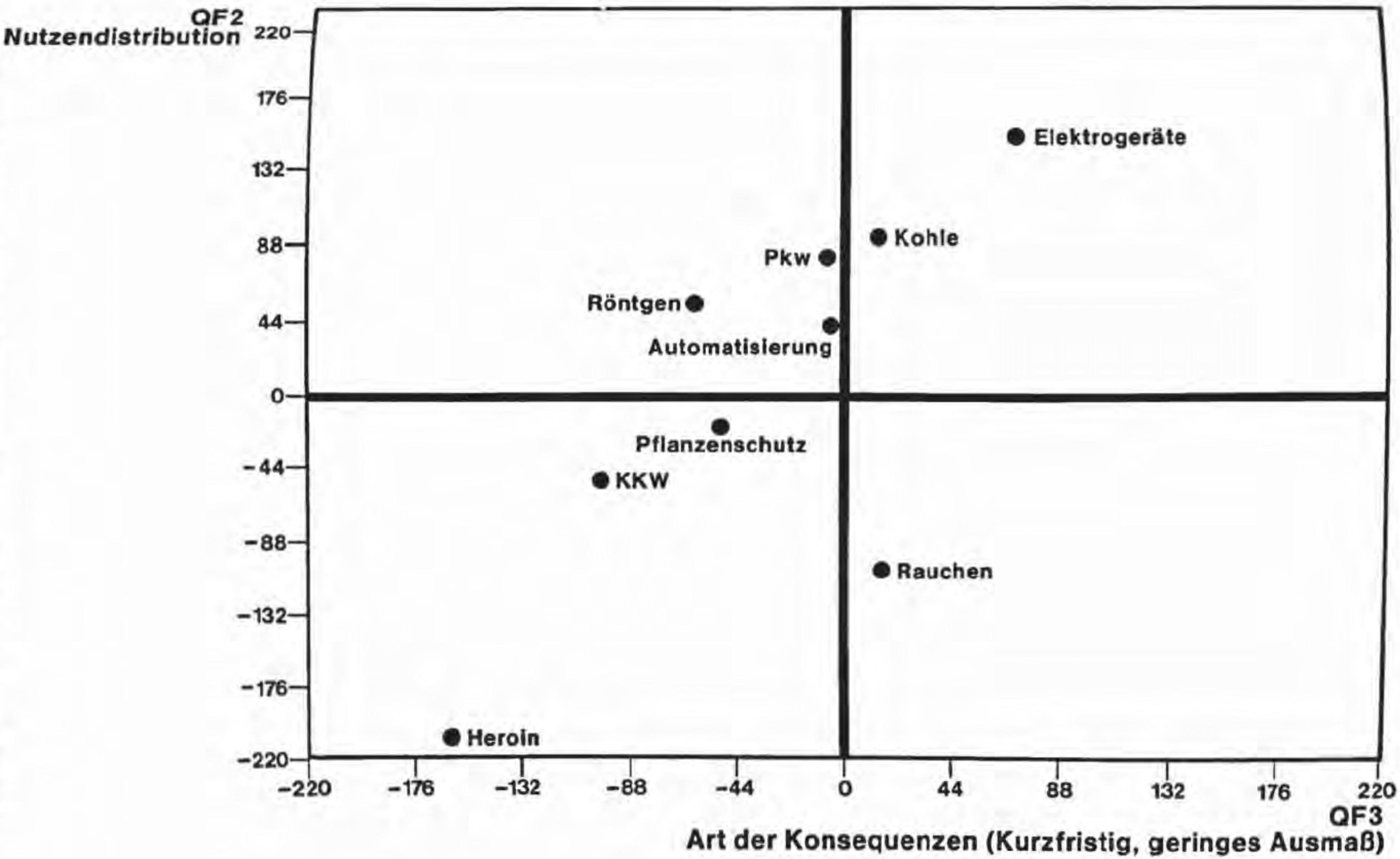


Fig. 21c: Aggregate Qualitative Risk Factors (Equal Risk-Benefit Distribution versus Severeness of Consequences)

the American values were plotted in addition. Similar to the graph presentation of the medians, a relatively similar basic pattern is found in both studies, but the American values are subject to greater dispersion and more frequently occupy extreme positions. This might be due to the relatively homogeneous sample of the interview subjects in the American studies.

The information content of these three figures can be summarized in three observations:

- Pesticides and nuclear energy are given negative evaluation in the case of all three qualitative factors, i.e. on the average there is a negative perception of benefit distribution, personal controllability and the degree of consequences. In view of the fact that these negative evaluations include a relatively high proportion of the explained variance for the risk evaluation in question, the conclusion is justified that extreme values in the qualitative risk characteristics have a marked effect on risk acceptance, while risk sources in the intermediate value range of the scale of qualitative characteristics are directly affected only by the benefit distribution component.

- Apart from the extremes discussed above, the central position of the benefit component (overall distribution and the individual's perceived self-utility) is clearly documented. The positive evaluation given to X-ray diagnostics, coal-fired power stations and motor cars runs parallel to the allocation of the benefit factor in each case (correlation values 0.71, 0.84, 0.76), while the more negative attributes of these three risk sources have only a minor effect on the overall evaluation in the case of the two risk-related factors (correlation values between 0.21 and 0.48).

Table 11: Comparison of Factor Loads to Qualitative Risk Characteristics in the German and American Studies (Fischhoff et al. '79, 112, p.145)

		German values	American values
Factor 1	voluntary	0.93	0.89
	known to science	0.83	0.88
	personal control	0.87	- 0.83
	familiar	0.90	- 0.87
	immediate	0.45	0.70
Explained variance		52.8%	58.9%
Factor 2	severity of consequences	0.89	0.91
	everyday risks*	0.82	0.60
	immediate risks	0.47	- 0.45
Explained variance		10.2%	21.1%
Factor 3	total benefits	0.93	not included in the scale
	benefit to the individual	0.93	
	safety monitored	0.92	
	immediate risks	0.72	
Explained variance		37.0%	

* in American survey: common risk

- In the opposite direction, the same applies to the evaluation of habit-forming products. Here we have a high negative correlation between benefit distribution and risk evaluation (smoking: $r = -0.79$; heroin: $r = -0.91$); however, the extremely positive values on the voluntariness scale have a compensating effect on the acceptance of the habit-forming product. Thus, in the case of the question as to future handling of the risk it is less a prohibition than a voluntary abstention which is demanded (at least with respect to alcohol and smoking). Consequently, the possible individualization of the risk influences the risk-benefit evaluation less than the type of acceptance decision. The tolerance of the smoking risk, therefore, does not arise from a lack of perception of risk consequences or their denial, but grows from the belief that the voluntariness of risk-taking requires only voluntary instruments of risk management.

On the whole, the qualitative characteristics appear to exhibit a preponderance of benefit distribution as the weighting factor for all risk sources. The two risk-related factors have a direct influence on risk evaluation only when certain threshold values which cannot be quantified here are exceeded.

Effect of Risk Propensity and Benefit Orientation

In empirical studies, characteristics such as high risk propensity or risk aversion can be measured only under great methodological difficulties. In the literature on decision-making theory these two characteristics play an important role for the determination of different types of decision-making processes (reckless or cautious). In the present study, risk propensity was measured by determining how consistently all 12 risk sources were overestimated or underestimated in the risk-benefit estimation. The scale values representing extremely high and extremely low estimates were selected from the responses for the benefit and detriment variables and from the values for the risk-benefit estimate as a combined variable. In addition, the frequency of the zero category indicated was introduced as a new variable. The newly formed variables were labelled as follows:

- benefit orientation (extreme emphasis on the benefits of risk sources);
- detriment orientation (extreme emphasis on the detriments of risk sources);
- high risk propensity (extremely positive risk-benefit estimate);
- risk neutrality (predominantly neutral risk-benefit estimate);
- risk aversion (predominantly negative risk-benefit estimate).

Consequently, five new characteristics were computed internally for each interview subject,the numerical value of which represents the degree of consistency of the risk propensity. For correlation analyses of the these five variables with one of the 12 risk-benefit estimates or with the risk evaluations, the associated benefit or detriment values were, of course, excluded from the consistency index so that, in the final analysis, each of the 12 risk sources had a correlation partner of its own (the values for the 11 other risk sources). This ensured that the variables used for correlation were independent from each other with respect to their composition.

The correlation values between the five consistency variables and the variable for risk evaluation and risk-benefit estimation have been compiled in Table 12.

The variables on risk propensity are highly significant for both dependent variables (risk-benefit estimation and semantic differential). Persons of high risk propensity or interview subjects with a preference for high benefit estimations gave a highly positive risk balance estimation for motor cars, aircraft and automation, but also nuclear energy and electrical appliances. The opposite relation, i.e. the estimates given by risk-aversive or detriment-oriented persons revealed the same trend, but the individual correlation values are only half as great. Persons who frequently marked the zero category were especially critical toward air traffic and had a slightly negative attitude toward motor cars and nuclear energy. These relations suggest the conclusion that a positive risk balance in the evaluation of the risk sources of air traffic, motor cars and nuclear energy requires an overall positive attitude toward risk-taking, while a neutral risk-taking attitude already leads to negative evaluations. Another striking feature of this table is that the risk evaluation for alcohol and smoking exhibits only slight dependence on the risk propensity characteristic. Only the risk-aversive persons transfer their negative risk-taking attitude to the habit-forming products. This results in an inverted relationship: while a positive risk evaluation of technological and industrial risk sources is associated with a positive risk propensity, this attitude is not required for the habit-forming products: this is indicative of a trend where habit-forming products which can be individualized are not classified as

Table 12: Dependence of the Risk-Benefit Estimation and the Semantic Differential on External Variables

Correlations External variables		High risk propensity	Risk aversion	Risk neutrality	Benefit orientation	Detriment orientation
Smoking	Risk	0.13	-0.44	-0.16	0.12	-0.37
	SD	0.07	-0.29	-0.13	0.05	-0.24
Electrical appliances	Risk	0.22	-0.12	-0.21	0.53	-0.09
	SD	0.23	0.03	-0.00	0.38	-0.09
Nuclear power stations	Risk	0.60	-0.48	-0.24	0.38	-0.60
	SD	0.46	-0.40	-0.30	0.46	-0.43
Aircraft	Risk	0.63	-0.29	-0.47	0.57	-0.49
	SD	0.53	-0.17	-0.23	0.55	-0.22
Alcohol	Risk	0.20	-0.37	-0.02	0.15	-0.39
	SD	0.17	-0.39	-0.03	0.02	-0.33
Coal	Risk	0.21	-0.14	-0.22	0.10	-0.17
	SD	0.13	-0.16	-0.04	0.14	-0.13
Motor cars	Risk	0.60	-0.31	-0.29	0.40	-0.41
	SD	0.32	-0.15	0.01	0.26	-0.15
Heroin	Risk	0.10	-0.08	0.02	0.07	0.05
	SD	0.01	-0.13	0.05	0.13	-0.15
Automation	Risk	0.61	-0.36	-0.27	0.41	-0.37
	SD	0.40	-0.30	-0.12	0.34	-0.20
Skiing	Risk	0.34	-0.29	-0.09	0.38	-0.23
	SD	0.30	-0.28	-0.08	0.42	-0.26
Skiing	Risk	0.29	-0.23	-0.24	0.23	-0.26
	SD	0.22	-0.17	-0.09	0.33	-0.12
Pesticides	Risk	0.44	-0.35	-0.13	0.28	-0.43
	SD	0.43	-0.32	-0.12	0.29	-0.30

Risk = risk-benefit estimation

SD = risk evaluation based on the summed values of the semantic differential

___ p = 0.99

\- - - p = 0.95

Table 13: Dependence of the Risk-Benefit Estimation and the Semantic Differential on External Variables

Correlations External variables		Sex	Age	Class	Political party preference CDU	SPD	FDP
Smoking	Risk	0.04	-0.21	-0.17	-0.04	0.01	-0.08
	SD	0.07	-0.18	-0.16	-0.02	0.02	-0.07
Electrical appliances	Risk	0.13	0.07	-0.09	0.13	-0.08	-0.12
	SD	0.08	0.05	-0.12	0.16	-0.07	-0.12
Nuclear power stations	Risk	-0.13	+0.19	+0.14	0.18	-0.17	-0.09
	SD	-0.17	+0.15	+0.14	0.22	-0.22	-0.10
Aircraft	Risk	-0.21	-0.10	0.14	0.06	-0.09	-0.03
	SD	-0.15	-0.19	0.16	0.05	-0.09	-0.09
Alcohol	Risk	-0.17	0.08	-0.21	-0.02	0.05	-0.06
	SD	-0.19	-0.15	-0.19	-0.08	0.04	-0.04
Coal	Risk	-0.13	0.10	0.11	-0.02	0.08	-0.18
	SD	-0.05	0.16	0.06	0.01	0.02	-0.19
Motor cars	Risk	0.06	0.08	0.07	-0.02	-0.11	-0.06
	SD	0.03	0.04	0.01	0.02	-0.15	-0.12
Heroin	Risk	-0.01	-0.22	+0.05	-0.10	0.10	-0.04
	SD	-0.04	-0.16	0.04	-0.11	0.14	-0.08
Automation	Risk	-0.01	+0.13	0.15	-0.13	0.03	-0.03
	SD	-0.05	+0.17	0.16	-0.12	0.00	-0.02
Skiing	Risk	0.06	0.10	-0.08	-0.05	0.01	-0.13
	SD	0.02	0.13	-0.15	-0.07	0.02	-0.13
Skiing	Risk	-0.24	0.25	0.13	0.02	0.03	0.01
	SD	-0.11	0.19	0.08	0.01	0.08	0.03
Pesticides	Risk	-0.46	0.22	-0.18	0.01	-0.07	0.06
	SD	-0.39	0.36	-0.17	0.07	-0.08	0.03

Risk = risk-benefit estimation

SD = risk evaluation based on the summed values of the semantic differential

___ p = 0.99

--- p = 0.95

CDU = Christian Democratic Party

SPD = Social Democratic Party

FDP = Liberal Party

less acceptable until a deliberately negative relationship to risk on the whole exists; technological or industrial risks, on the other hand, must already prove their justification when no positive attitude toward risk-taking exists. However, this inverted relation does not apply to heroin which is given such a high negative evaluation by all the interview subjects that significant correlations cannot exist at all.

However, the limits of interpretation capabilities must be pointed out once again: high correlation on the risk propensity scale merely means that interview subjects who gave very high or very low evaluations to 11 risk sources also did this consistently in the case of the twelfth source. Whether this trend toward consistency actually reflects the dispositive characteristic of risk propensity, the degree to which this is merely verbal, but not actual behaviour, whether some persons do not have different matrices and evaluation patterns for numerical values, cannot be clarified by the present study.

Effect of Demographic and Social Characteristics

Some demographic and social characteristics were also investigated as part of the risk perception study. Again, a few simple correlation analyses to determine the correlations with risk evaluation and risk-benefit estimation can reveal the effect of this variable. The coefficients have been compiled in Table 13.

First, it is clearly seen that political party preference does not play any role, with the exception of nuclear energy risk estimation. That nuclear energy would be more likely to receive a positive evaluation by conservative voters (Christian Democratic Party) and a negative evaluation by socialist party voters (Social Democratic Party) could have been expected on the basis of the most recent opinion polls; a detailed discussion will follow in Part V. But the variables of sex, age and class are of greater interest. This applies especially to pesticides, where women, younger persons and members of the upper classes are more likely to give negative evaluations. With the exception of class membership, the same applies to nuclear energy. In either case it is likely that the "artificial nature" of the risk source, the involuntary risk-taking which cannot be controlled by the individual and the possibility of catastrophic detriments have a greater repulsive effect on women and younger people. Even at this early time the prediction appears justified that pesticides and - through them - all chemical interventions in the food chain, from the point of view of the overall risk perception structure will encounter the same acceptance problems from which nuclear energy suffers today, although the topic may not be as controversial because the specific risk-benefit distribution for nuclear energy is still further removed from the congruent model than it is in the case of pesticides.

The sex variable also affects the risk estimation for aircraft, alcohol (but not smoking) and X-ray diagnostics. Again, only speculative explanation patterns can be given. It is possible that a fear of radiation which cannot be perceived by the sensory organs and a special sensibility with respect to health hazards are decisive for the negative evaluation of X-ray diagnostics by women; it is likely that women suffer from alcohol abuse by their mates more frequently than vice versa, and it is a known fact from the psychology of air traffic that women suffer greater anxieties prior to flying than men (which, however, is not yet an explanation of this phenomenon). The degree to which socialization-related factors (learning to express feelings), role-specific patterns (women are responsible for family, health and food) or even endogenous phenomena (hormone changes, pregnancy) are potential influencing parameters, would be an interesting problem for future studies.

Age- or class-specific relationships are less clearly developed. Nicotine and alcohol are given a more negative evaluation by the members of the upper classes, although they do not demand more stringent measures against them. Automation on the job exhibits a slightly positive correlation with class and a slightly negative correlation with age: contrary to the intuitive assumption that it is especially the older employees who feel insecure because of the introduction of modern machinery on the job, it is especially the younger employees with low occupational prestige who perceive the automation risk to be negative. Another surprising feature is the greater risk estimation for X-ray diagnostics given by young people: it is possible that this discrepancy is due to better information on potential radiation hazards on the part of the younger generation.

Finally, it should be mentioned that younger persons and members of higher classes are more likely to vote against a prohibition of heroin (and instead would prefer voluntary abstinence), and that both types of persons would also prefer more stringent measures against nuclear energy.

The comprehensive preparation for the present study in 1978 by accident yielded an interesting result. In the factor analysis of the evaluation scale, i.e. the Eishbein weighting factors (64 items) for the belief scale, three factors were revealed as significant dimensions which could be labelled as follows:

- direct, subject-related advantages and disadvantages (more benefits, greater income etc.);
- indirect, subject- and group-related advantages and disadvantages (health, education etc.);
- society-related and socio-political advantages and disadvantages (more democratic rights, economic advantages etc.).

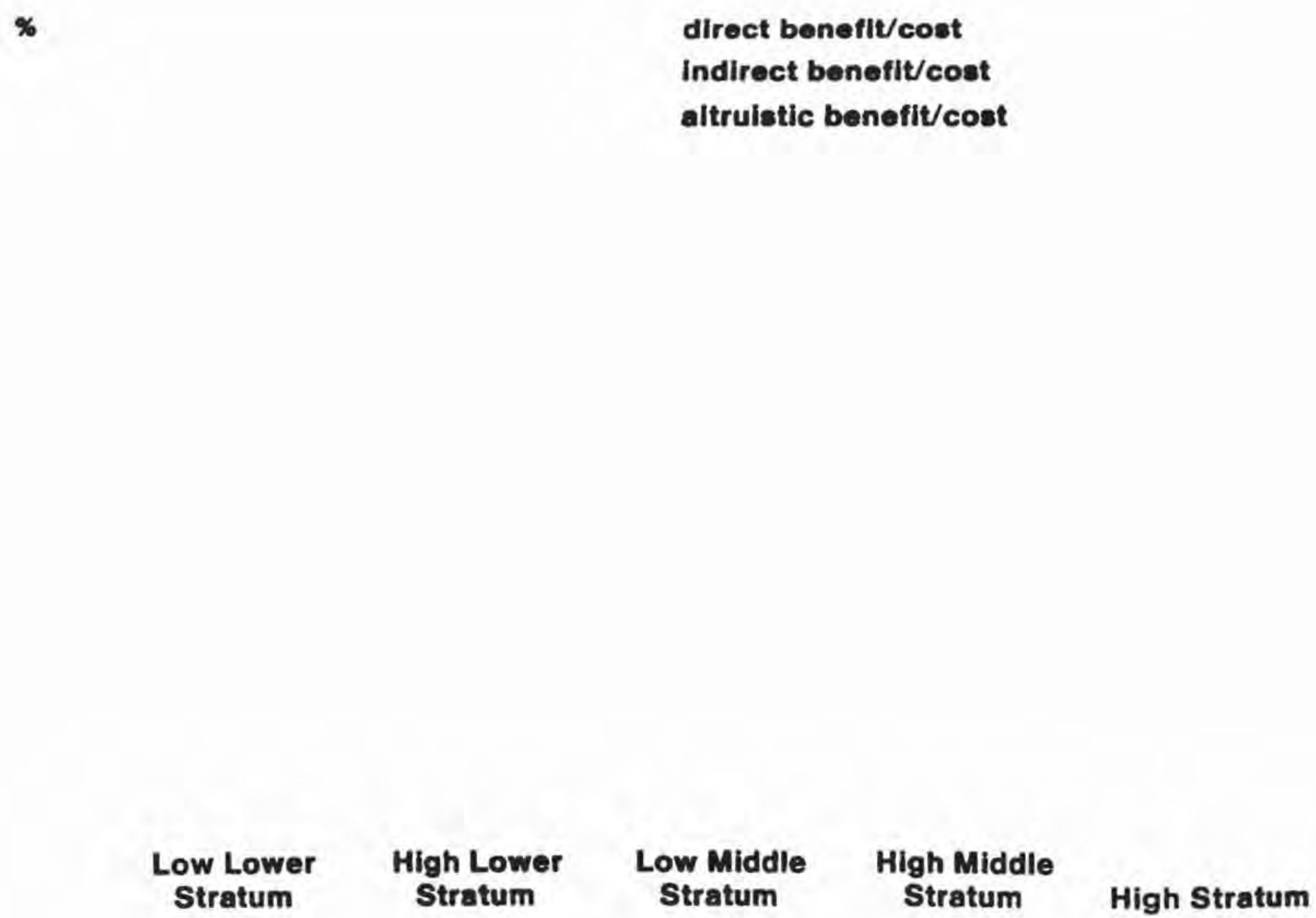
The subsequent correlation of these factors with class membership revealed a clear-cut relationship which has been plotted in Figure 22. This shows that the lower class attributes major weight to direct advantages, the lower middle class to indirect advantages and the upper middle class to the society aspects, while the upper class assigns the same weight to all three factors.

This result, which reveals class-specific weighting patterns for argumentation levels, was already presented as a thesis at the Miami Energy Forum in 1978 (Engelmann, Renn, '80, 96, p. 364).

In the survey itself, using 100 interview subjects each and a stricter belief scale, more differentiated class-specific differences in weighting behaviour were revealed. Similar to the factorial analysis of the aggregate belief scale, the analysis of the Fishbein weights (evaluation scale) revealed five factors:

- direct and indirect effects on health, life, happiness and security;
- economy- and society-related values such as quality of life, supply, social justice, environmental pollution;
- projective and political advantages and disadvantages such as modernization, advantages or disadvantages to future generations, progress of society, democratic rights;
- socio-political values such as freedom, participation by citizens, education, social justice;
- direct personal advantages and disadvantages such as pleasure, financial advantages, convenience, happiness.

Figure 23 shows the relative significance of these five factors for each class category. Similar to the preliminary studies, the significance of subject-related aspects declines with class level, but without leading to any differentiation between direct or indirect consequences. At the same time, the importance of society- and economy-related values rises with the class index on the average. Projective advantages and disadvantages are given a higher evaluation from the lower middle class up, but the differences are relatively small here. Also, political aspects such as freedom and participation by the citizens are evaluated as important only from this class level, and the proportion of this factor rises continuously until the upper class is reached. The lower class and - to a slightly lesser degree - the upper class attribute more weight to direct, personal advantages such as pleasure and convenience than the two middle classes.


%
direct benefit/cost
indirect benefit/cost
altruistic benefit/cost
Low Lower Stratum
High Lower Stratum
Low Middle Stratum
High Middle Stratum
High Stratum

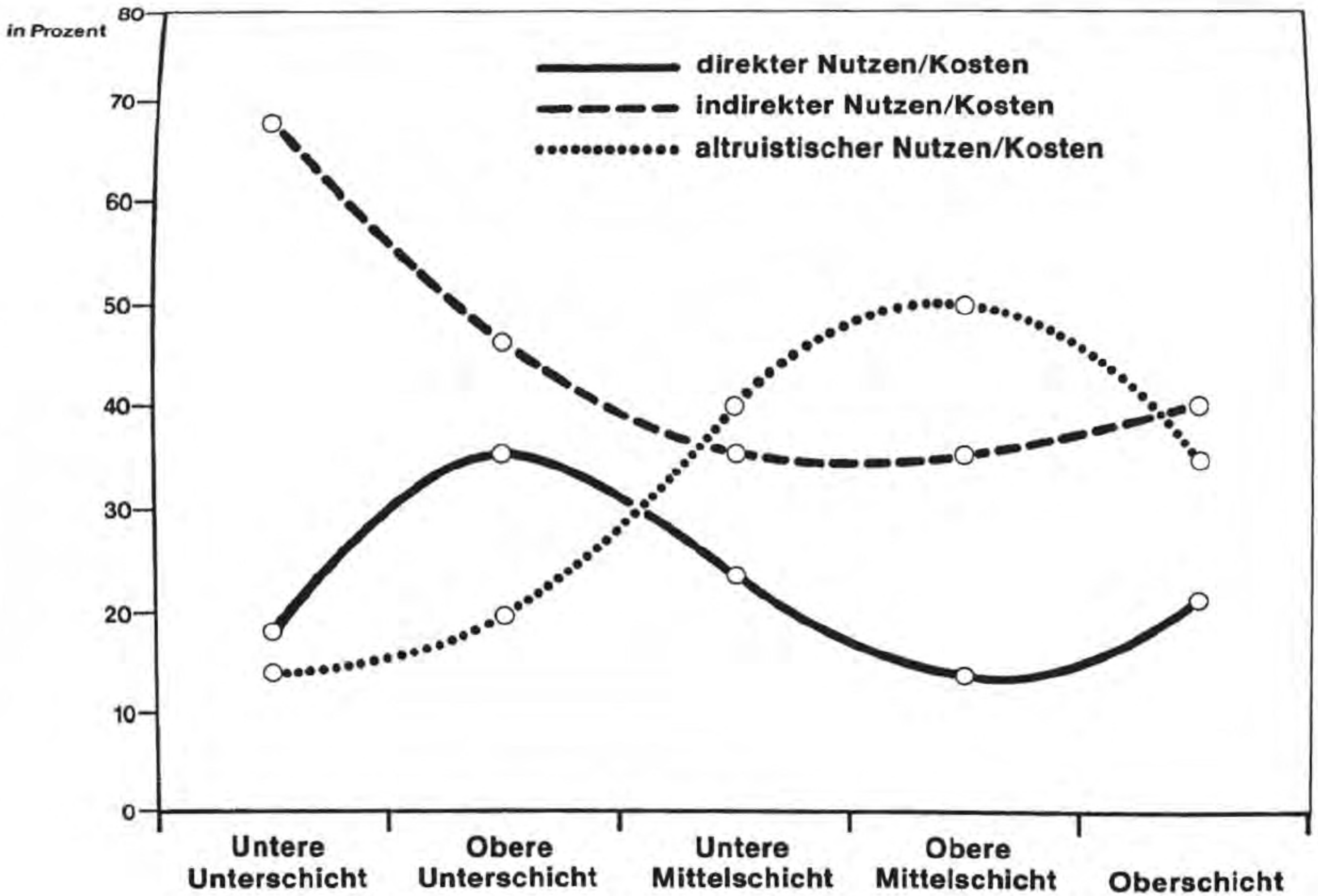


Fig. 22: Weighting of Belief Factors as a Function of Class Membership (Pretest Results)

(%)

Low Lower Stratum	High Lower Stratum	Low Middle Stratum	High Middle Stratum	High Stratum

Personal Advantages/Pleasure (Factor 5)
Sociopolitical Values (Factor 4)
Projected Consequencies/Political Values (Factor 3)
Economic and Social Values (Factor 2)
Personal Direct and Indirect Advantages (Factor 1)

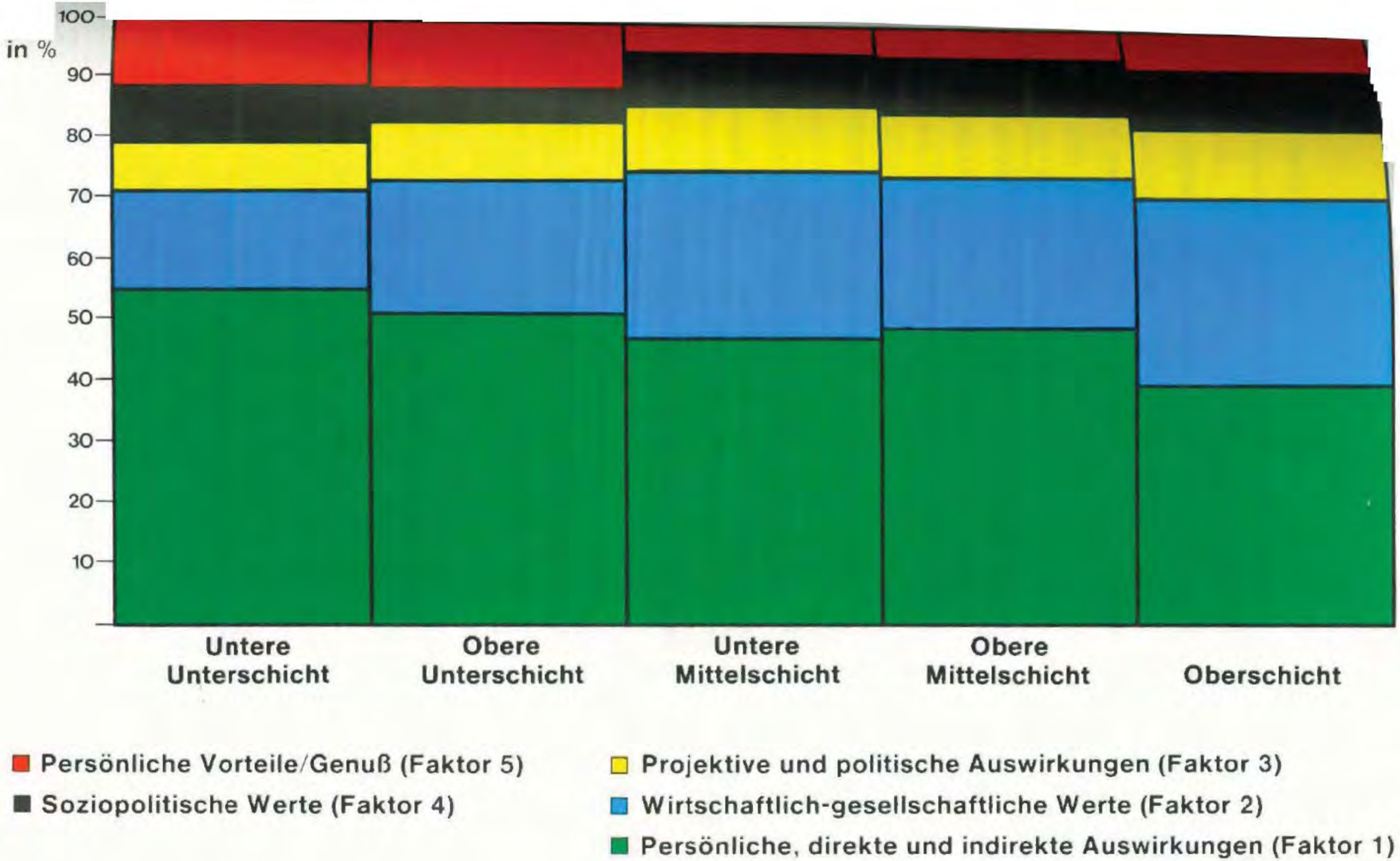


Fig. 23: Weighting of Aggregate Belief Factors as a Function of Class Membership (Main Study)

A detailed interpretation of these class-specific evaluation patterns would go beyond the bounds of this study. Thus, it could be discussed in detail whether the middle class, which is especially receptive to career stimuli, deliberately reduces the importance of aspects reflecting a positive attitude toward life, such as pleasure and convenience (in the form of sublimation), or whether it has internalized the ascetic way of life in the sense of Max Weber's theories on the relationships between capitalist advancement and anti-consumption values. Also in reference to participation research, the question concerning the degree to which demands for democratic participation rights, citizen's participation and political freedom are not typical interests of an upper class which is privileged in any event, would have to be clarified. In the present study these questions can only be mentioned briefly.

Overall Analysis of the Factors Influencing the Perception and Acceptance of Risks

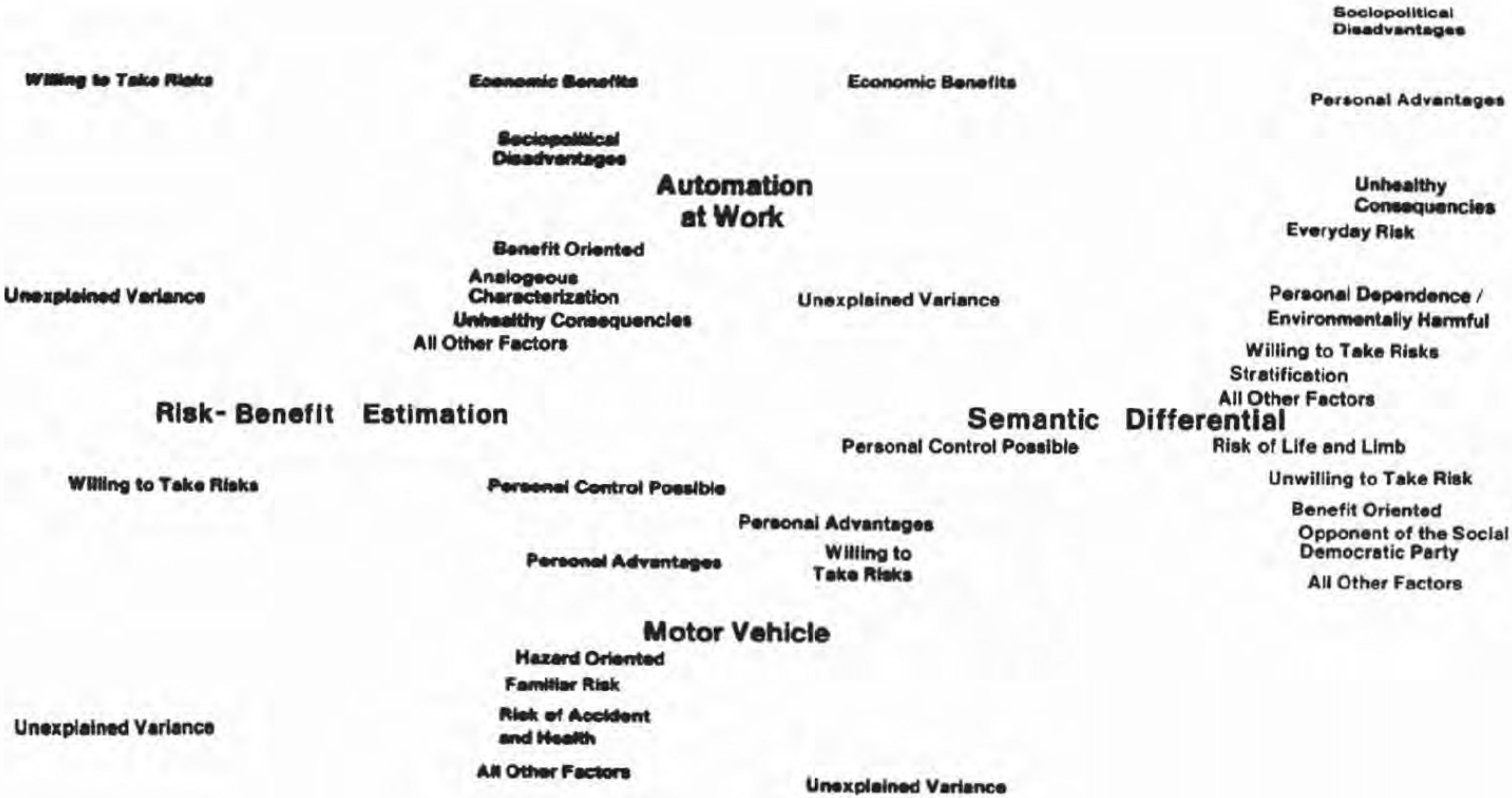
Up to this point, the analysis of the results on risk perception was limited to a gradual incorporation of the relevant classes of variables: first, the specific beliefs on each risk source, subsequently the qualitative characteristics and finally the external factors were discussed. In addition, evaluation of the semantic differential whose summated value was used as the indicator for risk source evaluation revealed several additional influencing factors which were labelled as follows:

- security,
- scientificality,
- analogue classification (such as sympathetic, ethical),
- power.

In order to determine the ranking of each of these factors for the evaluation of the risk source, a multiple regression was made by introducing all the relevant factors of the different classes of variables and the demographic and social characteristics as independent parameters and determining their relative weights on the basis of the values for the explained variance of the two dependent variables (risk-benefit estimation and risk source evaluation). However, this type of overall statistical evaluation must be interpreted with special caution since common interaction effects between the variables are taken into consideration but their internal, causal structure is concealed. In particular, it should be pointed out that social structure data such as age and class have a quite different relationship to the dependent variable than, for instance, the different qualitative characteristics which in turn can depend on the social data.

The six belief factors, the five most important qualitative characteristics (not summarized) and five of the six factors of the semantic differential (but only for the regression of the risk-benefit estimation), excluding the "general evaluation" factor, and the external variables of "dispositive risk propensity" and social structure data were selected as independent variables for each risk source. The total number of variables was 32 since dummy variables were used for the data which were not subjected to interval-scaling (sex, political party preference). As in the preceding chapters, the risk-benefit estimation and the sum indices for the semantic differential served as dependent variables.

The individual classes of variables are colour-coded in Figures 24a to 24e (green = social and demographic characteristics ; blue = belief scale factors; red =



Sociopolitical Disadvantages
Willing to Take Risks
Economic Benefits
Economic Benefits
Personal Advantages
Sociopolitical Disadvantages
Automation at Work
Unhealthy Consequencies
Everyday Risk
Benefit Oriented
Analogeous Characterization
Unexplained Variance
Unexplained Variance
Personal Dependence / Environmentally Harmful
Unhealthy Consequencies
All Other Factors
Willing to Take Risks
Stratification
All Other Factors
Risk- Benefit Estimation
Semantic Differential
Personal Control Possible
Risk of Life and Limb
Willing to Take Risks
Unwilling to Take Risk
Personal Control Possible
Benefit Oriented
Personal Advantages
Opponent of the Social Democratic Party
Personal Advantages
Willing to Take Risks
All Other Factors
Motor Vehicle
Hazard Oriented
Familiar Risk
Unexplained Variance
Risk of Accident and Health
All Other Factors
Unexplained Variance

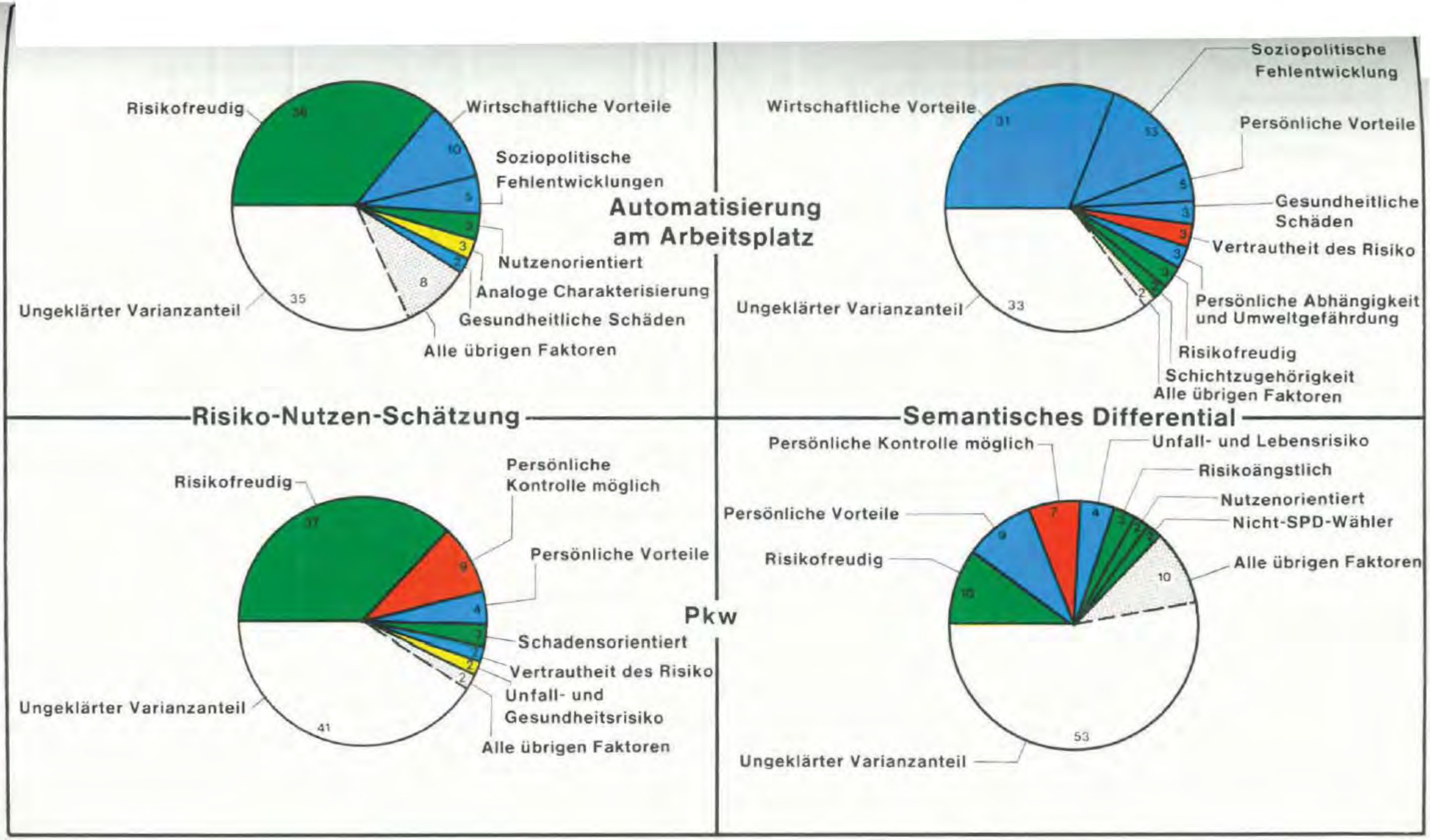
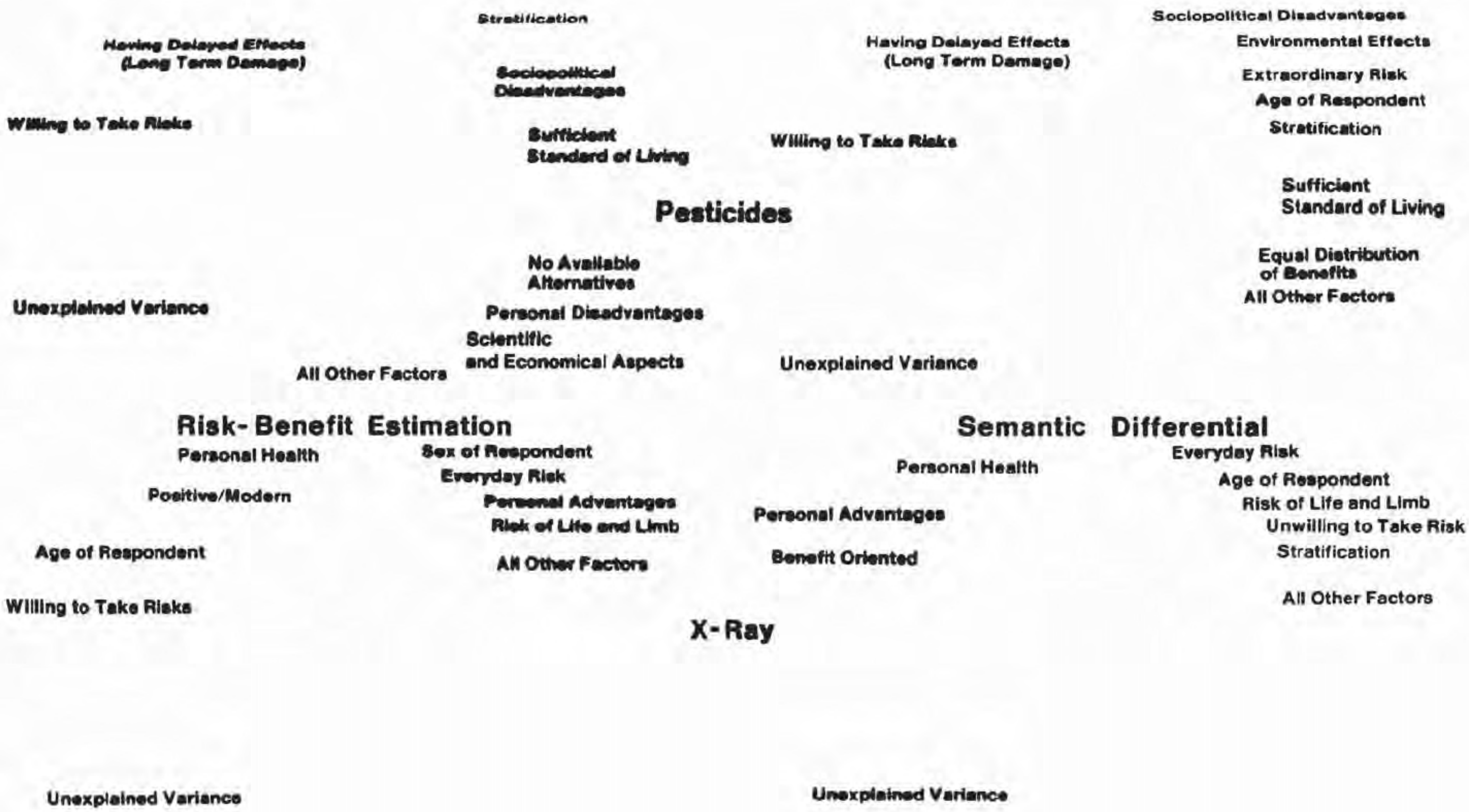


Fig. 24a: Graphic Representation of the Multiple Regression Values of all Independent Variables for the Semantic Differential of Nine Risk Sources



Pesticides
Risk-Benefit Estimation
Having Delayed Effects (Long Term Damage)
Stratification
Sociopolitical Disadvantages
Willing to Take Risks
Sufficient Standard of Living
No Available Alternatives
Unexplained Variance
Personal Disadvantages
Scientific and Economical Aspects
All Other Factors
Semantic Differential
Sociopolitical Disadvantages
Having Delayed Effects (Long Term Damage)
Environmental Effects
Extraordinary Risk
Age of Respondent
Stratification
Willing to Take Risks
Sufficient Standard of Living
Equal Distribution of Benefits
All Other Factors
Unexplained Variance
X-Ray
Risk-Benefit Estimation
Personal Health
Sex of Respondent
Everyday Risk
Positive/Modern
Personal Advantages
Risk of Life and Limb
Age of Respondent
All Other Factors
Willing to Take Risks
Unexplained Variance
Semantic Differential
Personal Health
Everyday Risk
Age of Respondent
Risk of Life and Limb
Personal Advantages
Unwilling to Take Risk
Stratification
Benefit Oriented
All Other Factors
Unexplained Variance

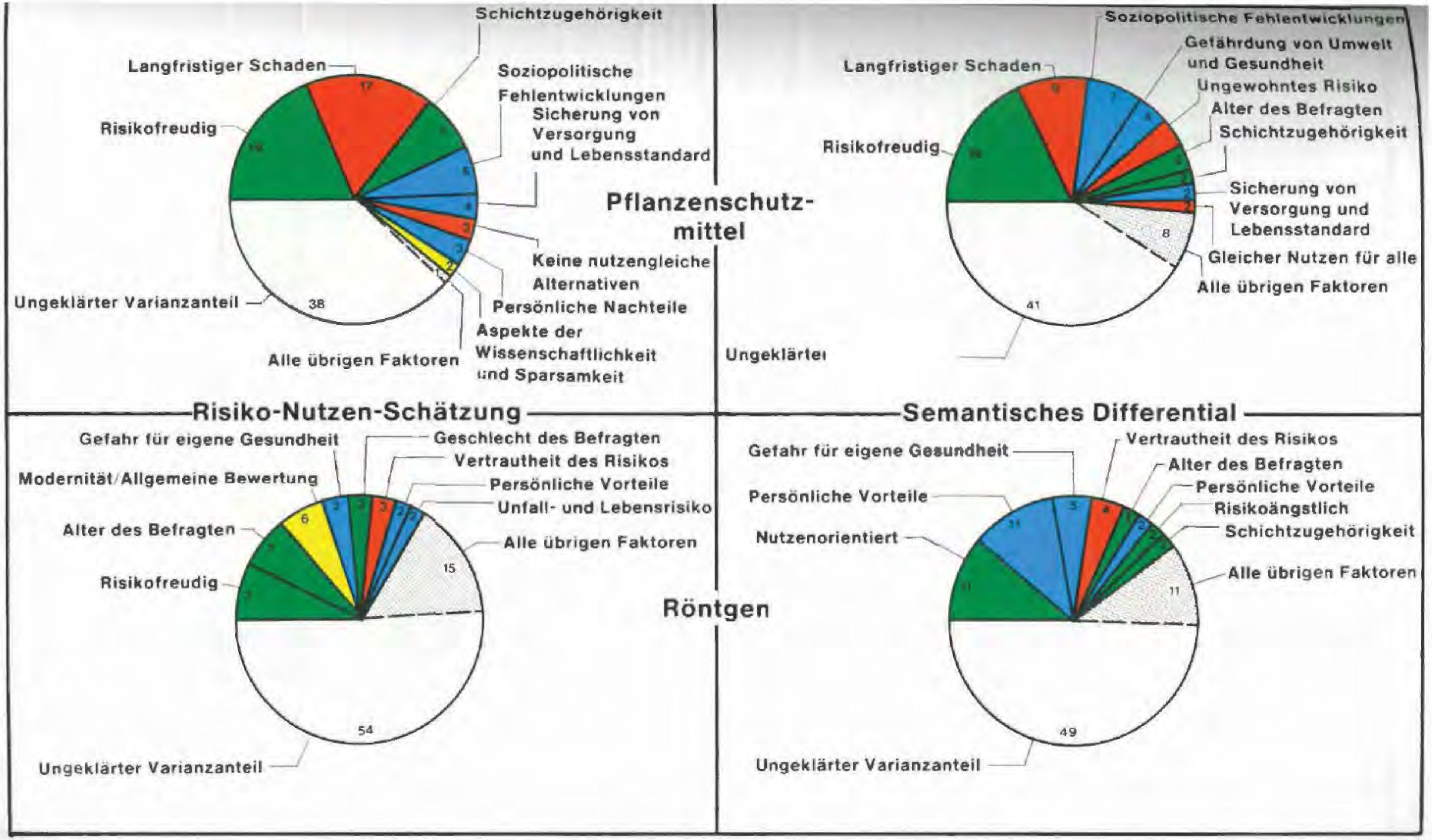


Fig. 24b: Graphic Representation of the Multiple Regression Values of all Independent Variables for the Semantic Differential of Nine Risk Sources

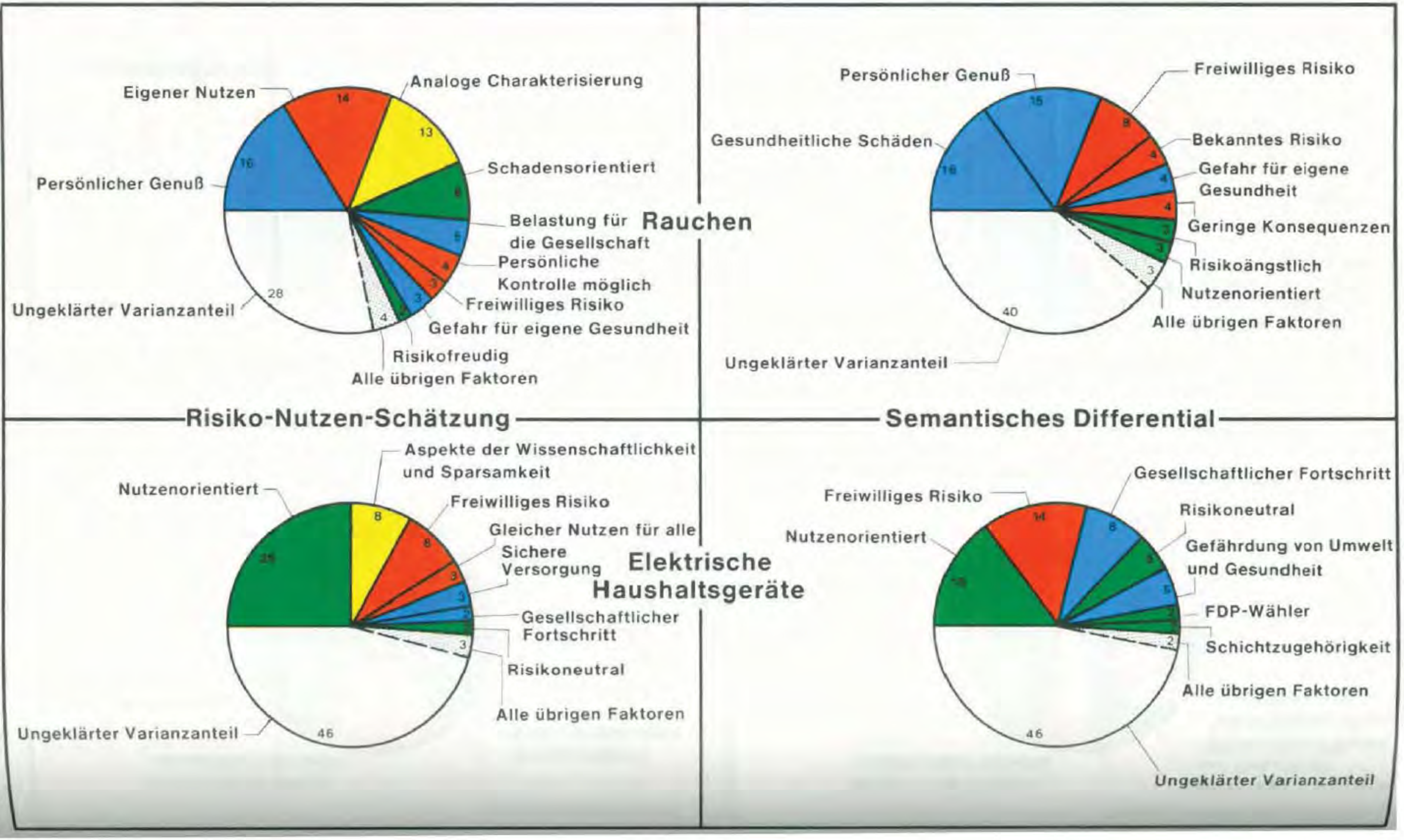
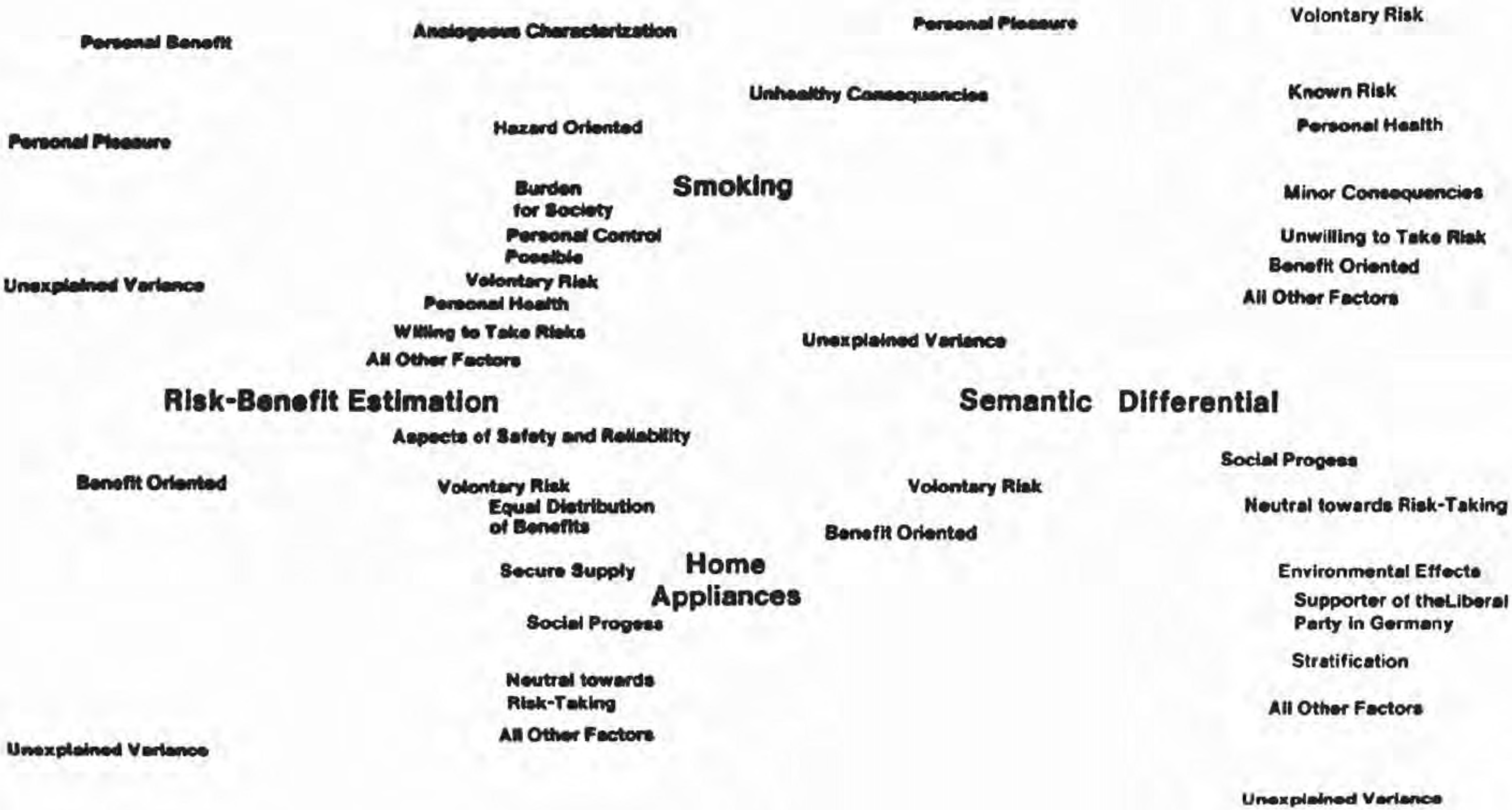


Fig. 24c: Graphic Representation of the Multiple Regression Values of all Independent Variables for the Semantic Differential of Nine Risk Sources


Personal Benefit
Analogeous Characterization
Personal Pleasure
Volontary Risk
Unhealthy Consequencies
Known Risk
Hazard Oriented
Personal Pleasure
Personal Health
Burden for Society
Smoking
Minor Consequencies
Personal Control Possible
Unwilling to Take Risk
Benefit Oriented
Unexplained Variance
Volontary Risk
Personal Health
All Other Factors
Willing to Take Risks
Unexplained Variance
All Other Factors
Risk-Benefit Estimation
Semantic Differential
Aspects of Safety and Reliability
Social Progess
Benefit Oriented
Volontary Risk
Volontary Risk
Equal Distribution of Benefits
Neutral towards Risk-Taking
Benefit Oriented
Secure Supply
Home Appliances
Environmental Effects
Supporter of theLiberal Party in Germany
Social Progess
Stratification
Neutral towards Risk-Taking
All Other Factors
All Other Factors
Unexplained Variance
Unexplained Variance


Risks on Safety and the Environment
Unhealthy Consequencies
Willing to Take Risks
Immediate Effects
Security for the Future
Equal Distribution of Benefits
Benefit Oriented
Environmental Effects
Coal
Personal Advantages
Environmental Effects
Immediate Effects
Benefit Oriented
Economic Benefits
Member of a Labour Union
Equal Distribution of Benefits
Unexplained Variance
All Other Factors
Unexplained Variance
All Other Factors
Risk- Benefit Estimation
Semantic Differential
Willing to Take Risks
Severe Consequencies
Political Dependencies
Challenging Personal Freedom of Action
Nuclear Power
Willing to Take Risks
Extraordinary Risk
Unexplained Variance
Unexplained Variance
No Personal Control
No Personal Control
Sex of Respondent
Sufficient Standard of Living
Political Dependencies
All Other Factors
Economic and Technical Advantages
Opponent of the Social Democratic Party

Fig. 24d: Graphic Representation of the Multiple Regression Values of all Independent Variables for the Semantic Differential of Nine Risk Sources

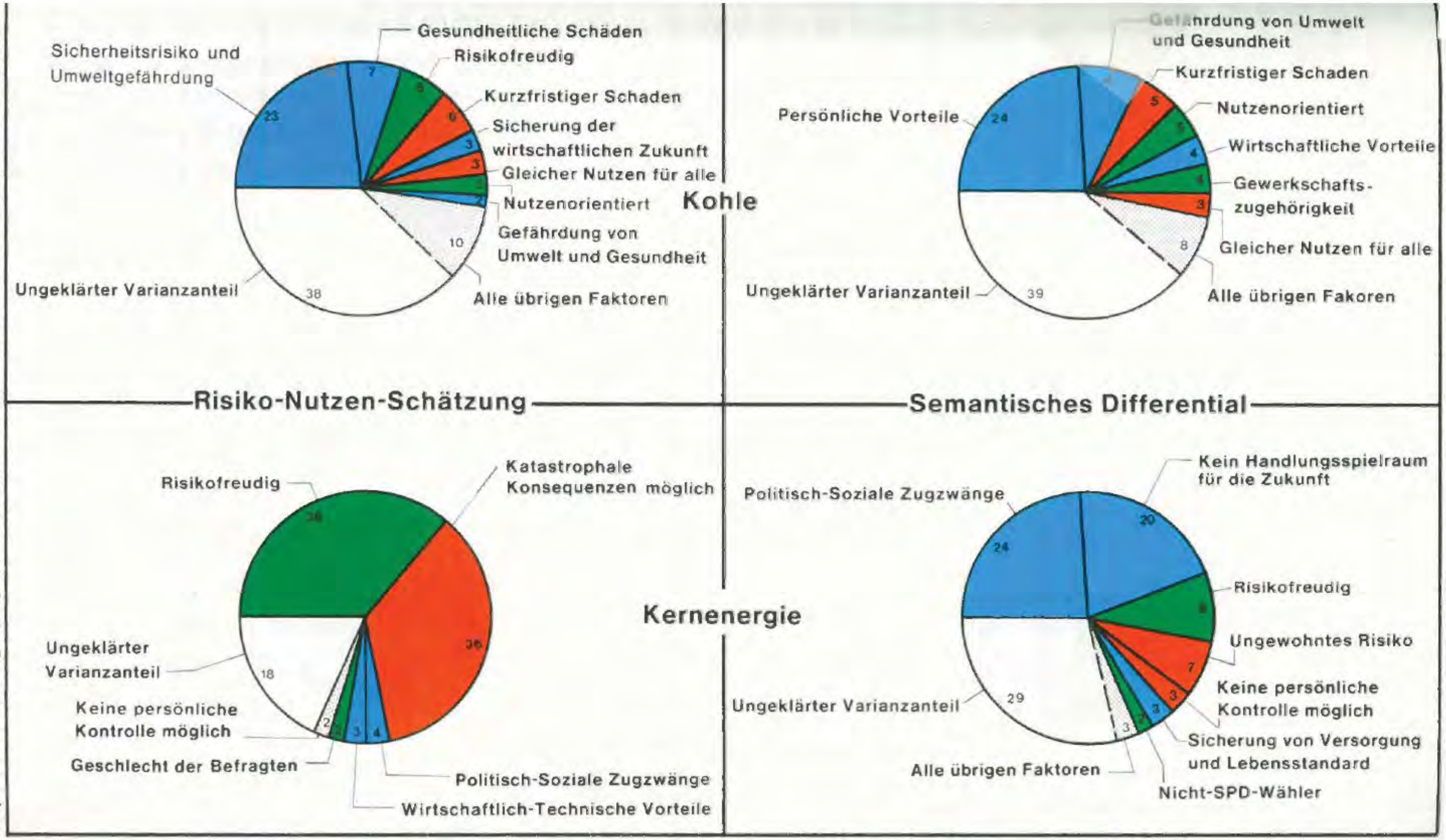
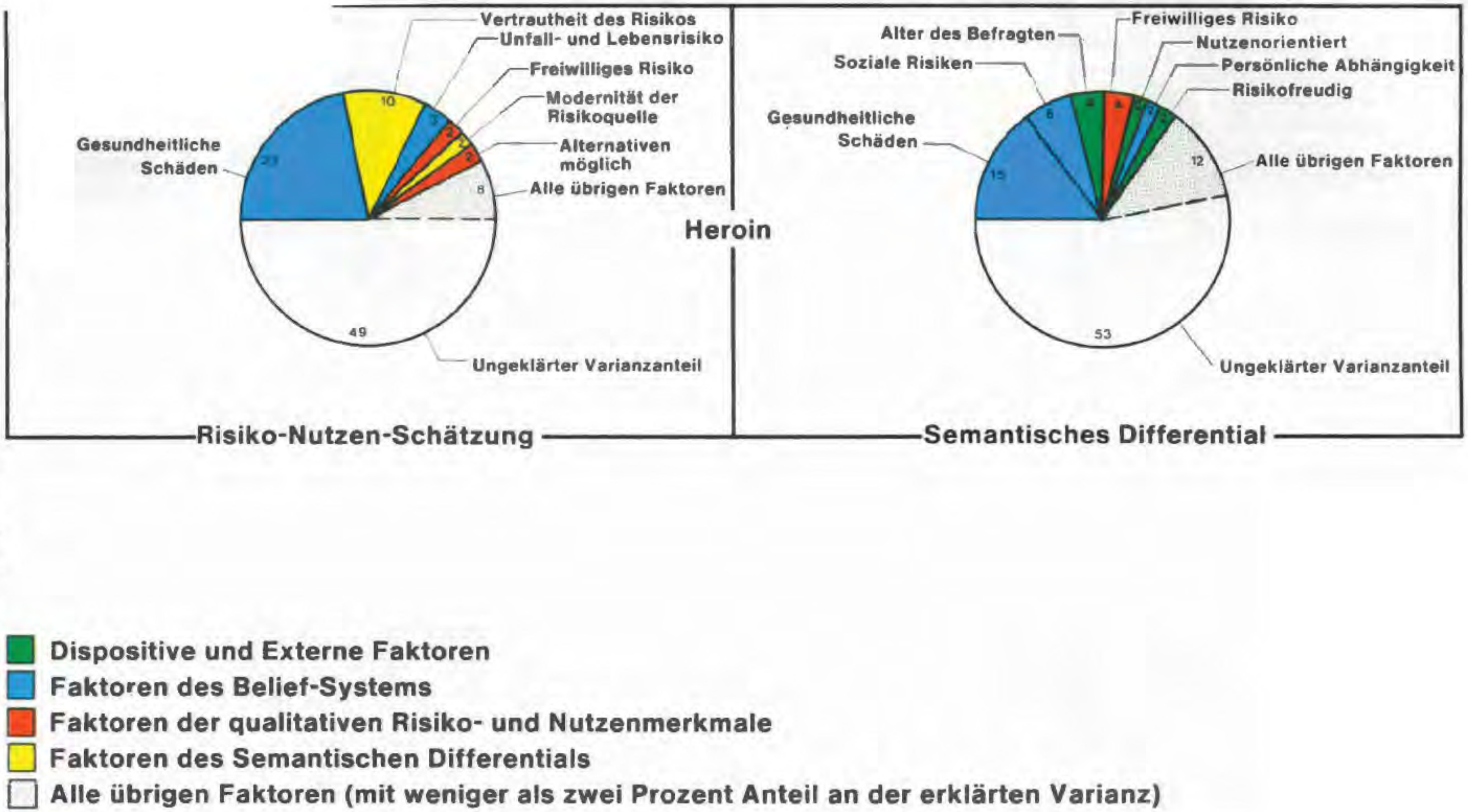


Fig. 24e: Graphic Representation of the Multiple Regression Values of all Independent Variables for the Semantic Differential of Nine Risk Sources



Familiar Risk
Risk of Life and Limb
Volontary Risk
Modern - Old Fashioned
Available Alternatives
All Other Factors

Unhealthy Consequencies

Age of Respondent
Social Risks
Unhealthy Consequencies

Volontary Risk
Benefit Oriented
Personal Dependency
Willing to Take Risks
All Other Factors

Heroin

Unexplained Variance

Unexplained Variance

Risk-Benefit Estimation

Semantic Differential

Dispositive and External Factors
Factors of the Belief - System
Qualitative Risk - and Benefit-Properties
Factors of the Semantic Differential
All Other Factors Accounting for Less Than Two Percent of the Explained Variance

qualitative characteristics; and yellow = semantic differential factors) so that the significance of these classes becomes evident at first glance. The first striking feature is the low explained value of the semantic differential factors, where the basic factor, general evaluation, had of course not been included. Factor 2 of the semantic differential, security and risk, plays a role only in the case of coal, nuclear energy and electrical appliances, while it does not appear at all in the case of the habit-forming products. But, belief scale factors of similar content are represented in the case of smoking, heroin, pesticides, X-rays and motor cars, so that it is a natural assumption that these factors have better correlation with the dependent variables; thus, they conceal the information content of the semantic differential factors which have a similar content, so that they no longer yield any additional explained values.

In the case of the qualitative risk-benefit characteristics, the previously observed trend is confirmed that risk-benefit estimation or risk source evaluation are affected only when certain threshold values have been exceeded. Thus, it is seen in the case of the habit-forming products that a clear emphasis exists on the voluntary nature of risk-taking, and in the case of nuclear energy and pesticides that there is a strong weighting in terms of the type and severeness of risk consequences. Also, the individual controllability component in the case of the motor car is more clearly expresed in this final analysis than it was in the individual evaluations. On the other hand, the benefit component which dominated in the analysis of qualitative characteristics declines in significance, probably due to the fact that distribution aspects are already covered by the statements on the belief scale.

The belief scale factors and dispositive characteristics or social data (blue, green) account for the greatest proportion of the explained value. And the risk evaluation values can claim special validity because the internally acquired variables of risk propensity and benefit detriment orientation are genuinely independent.
What are the conclusions which can be drawn for the individual risk sources?

In the case of smoking and heroin the belief factors of health, risk to life and pleasure are predominant. The effect of general benefit-or-detriment orientation is less developed. In the case of nuclear energy and pesticides, risk propensity appears to be a necessary prerequisite for positive evaluation. In both cases, this variable plays a primary role. Socio-political and security-specific problems as well as the qualitative risk characteristics of "delayed and catastrophic consequences" take second place. The positive aspects of benefits, supply, economic and projective advantages are characterized by low variance components only. On the other hand, belief in possible personal advantages and consequences to health dominate in the case of coal and X-rays. These subject-related variables have a decisive influence on attitudes toward these risk sources.

Risk propensity is also an important explanation factor in the case of motor cars and automation. Persons who exhibit a high verbal risk propensity apparently transfer this attitude especially to motor cars and automation and, to a slightly lesser degree, to pesticides and nuclear energy, while persons of greater risk-scepticism give these risk sources an excessively negative evaluation.

The positive and negative belief factors are approximately balanced in the case of automation and motor cars. Economic and personal advantages are in favour of technology on the job and, at the same time, the perception of social disadvantages and the health hazard play a role as well. The motor car is associated with the fulfillment of personal desires and values, but also with pollution and accident risk as negative effects.

Benefit-orientation is of primary significance for the evaluation of electrical appliances, meaning that persons who, on the whole, consider all risk sources from the point of view of their advantages, tend especially to transfer this attitude to electrical home appliances. In addition, the factors of voluntariness, economic advantages and progress to society have an effect.

The presentation of the different components of the explanation level in the form of circular segments demonstrates that the belief structure, the qualitative risk-benefit characteristics, some dispositive characteristics and - to a lesser degree - semantic differential factors can be used to explain approximately 50 to 60% of the variance encountered in the risk-benefit estimations and in the sum index of the semantic differential.

Figures 24a to 24e also demonstrate the weaknesses of aggregate analyses: new, hardly typifiable explanation patterns result for each risk source which in themselves are quite plausible but can certainly not be reduced to general structures which can be generalized for risk acceptance. If we introduce aggregate data into the analysis, we create not only an artificially homogenized framework so that the different risk sources can be viewed through standardized spectacles; we also obtain relative values over 0.90 which are not confirmed by the individual analysis, or only to a much lesser degree. Impressive proof for this data manipulation can be found through a regression of the aggregate influencing factors for all 12 risk sources. Compared to the correlation values to which we have become accustomed in the social sciences, Table 14 reveals a truely sensational result:

Table 14: Aggregate Regression Analysis for the Sum Index of the Semantic Differential

Independent variable	Summated correlation	Declared variance	Additional explanation value	Simple correlation
S 6 (summated beliefs)	0.959	0.92	0.92	0.96
S 5 (personal advantages and disadvantages)	0.974	0.95	0.03	0.86
Q 2 (risk distribution)	0.986	0.974	0.03	0.96
Q 1 (voluntariness)	0.992	0.98	0.01	-0.30
Q 12 (no alternatives)	0.999	0.998	0.01	-0.38
Q 8 (minor consequences)	1.00	1.00	0.001	0.47

With the aid of six variables, the median of the independent variable, risk evaluation, can be predicted to an accuracy of two decimal places. This type of deterministic relationship is rarely found even in the natural sciences. As much as we might be pleased by this clear-cut and satisfying result, we must consider it a product of the statistical procedure used where the greater part of the non-clarified variance has been excluded by forming the mean-values, since the individual data were aggregated into nine cases (risk sources representing the individual case). If we neglect, for the moment, the quantitative values and study only the influence chain as such, the results of these regressions can be interpreted in a quite meaningful way.

The most important influencing factor is the sum index of the belief scale, followed by the perceived subjective advantages and disadvantages (which in part are already contained in the sum index). The third place is occupied by risk distribution, again an indication of the significance of this factor to risk perception, followed by the qualitative risk characteristics of "voluntariness, no alternatives possible and minor consequences". If we use only the aggregated values, we can draw the conclusion that a risk source which is characterized by an overall positive belief structure, by perceived subjective advantages, by voluntary risk-taking, by an equal distribution of benefits and risks, by the absence of catastrophic effects and by the absence of any alternative of equivalent benefits, is accepted without any problem.

This rule provides little information on the risk sources whose acceptance is subject to conflict : in the case of nuclear energy and pesticides as well as the habit-forming products, specific risk perception patterns occur, such as the socio-political aspects, each of which have an effect on the risk-taking decision, but without contributing to the explanation model on the aggregate level. At best, this six-variable model can be used as a starting point for risk evaluation, provided that the specific characteristics of the risk sources in question are also analysed in detail. To that extent, a possibility develops in principle whereby a global model can first be used for a rough acceptance determination, to be followed by individual analyses to clarify the degree to which special factors in the different factor classes influence the empirical acceptance by the population.

Part V

Nuclear Energy Attitudes and their Determinants - Results of Sampling Surveys

Post-War Nuclear Energy Attitudes of the Population of the Federal Republic of Germany

Since the early fifties, nuclear energy and nuclear power stations have been popular topics for commercial and academic opinion polling. While, in the fifties and sixties, public interest was centered on nuclear weapons applications, interest shifted to the peaceful uses of nuclear energy in power-generating reactors toward the mid-sixties. A brief historical description of the different phases of nuclear energy attitude formation is useful for following the trend of public opinion-forming over time (cf. Table 15). As far as the fifties are concerned, American studies must be used predominantly (Erskine, '63, 102, p. 180 ff.; Douvan and Withey '54, 82, p. 1 ff.; Levine and Modell '65, 221, p. 275 ff.; Fischer et al, '51, 113, p. 86 ff.; Back and Gergen '63, 20, p. 428 ff.) since German polling institutions did not conduct major nuclear energy surveys until 1969.

Phase I: Until approximately 1950/51, there was an ambivalent attitude toward nuclear energy: on the one hand, there was the fear of the horrors of nuclear warfare, and on the other hand the acknowledgement that nuclear weapons were significant to ensure the military superiority of one's own country. During this period, the peaceful use of nuclear energy plays no role at all and is either not perceived, or only vaguely so (Erskine, '63, 102, p. 180; Paschen, '78, 307, p. 3; Bieber, '77, 33, p. 3 ff.; Renn, '77, 331, p. 7 ff.).

Phase II: During the fifties, there was a clear reversal of public opinion against nuclear weapons which found an expression in the Easter marches.

A nuclear weapons stop was demanded world-wide, and nuclear fall-out was considered a threat to one's own health, especially in the United States. The Atoms for Peace movement, initiated by President Eisenhower, created a counter-movement to the military threat and hopes for a reversal of man's destructive intellectual potential into a harnessing of natural resources for humane purposes. This metaphysical embellishment of nuclear energy, promoted for political reasons, prepared the first step toward a symbolic role of nuclear energy as a paragon of technology and innovation (Douvan and Withey, '54, 82, p. 2; Rosi, '65, 345, p. 290 ff.; Levine, Modell, '65, 221, p. 275; Häfele, '75, 154, p. 44 ff.; Renn, '77, 331, p. 11 ff.)

Phase III: When the test stop agreement was signed between the United States and the USSR, the spearhead of protest against nuclear weapons was broken; nuclear weapons took second place after the problems of substitute wars (such as Vietnam). The theory of the arms balance also gained ground among the population and, in addition, the renunciation of nuclear bomb tests in the atmosphere reduced the general anxiety threshold. The question of peaceful uses still had little relevance. While there were still protests against the construction of research reactors in the fifties, where the typical characteristics of traditional technological adaptation problems existed, the first commercial nuclear power stations could be commissioned in the late sixties without any appreciable protest or resistance (Bieber, '77, 33, p. 82 ff.; Schuster, '71, 403, p. 113 ff.; Erskine, 102, p. 162 ff.; Renn, '77, 331, p. 9 ff.)

Table 15: Popular Opinions on Nuclear Energy Over Time (1945 - 80)

Phases	Years	Attitude toward nuclear weapons	Attitude toward peaceful uses	Knowledge level	Polarization
I	40-50	slightly negative, but acknowledgement of the nuclear balance of forces	not yet differentiated	low	hardly any
II	51-62	very negative	slightly positive, but still not very relevant	low	greater for weapons applications
III	63-69	fairly neutral, less relevant	fairly positive, hardly negative, high degree of indifference	better, but still low	none
IV	69-75	no longer as relevant as before, except for proliferation fears	great majority positive, 20-30% negative, 10-15% indifferent	fairly adequate	greater
V	76-78	no longer relevant	30% positive, 25% negative, 45% ambivalent	relatively high	great
VI	79-80	regains public influence	dualism beween perceived insecurity and belief in the necessity of nuclear energy	relatively high	great, but weakening in confrontation

Phase IV: In the late sixties and early seventies, the criticism of peaceful nuclear energy uses which had been aroused in the United States was seized upon in the Federal Republic of Germany. The problems were first discussed among scientists and only then presented to the public by professional critics. At the same time, local resistance to the construction of nuclear facilities developed.

None of this would have had the result that nuclear energy grew into a major political problem if the symbolic nature of nuclear energy which had developed in the fifties had not been seized again and reinterpreted. The developing awareness of the limits of growth, the greater interest in post-material values on the part of younger people with university education, the greater sensitization of the population for environmentalism and nature, and the disappointed hopes as to the effects of technological and scientific progress (such as space flight or cancer research) had the result that, in the minds of many individuals and groups, the symbolic attributes of nuclear energy, such as "progressive, clean, centralized and complex", turned into a negative connotation.

In spite of the first opposition fronts against nuclear energy, there was initially a solidarity with pro-nuclear energy groups in the Federal Republic of Germany, most of which were close to the established institutions in politics and society (cf. Table 16). Opinion polls confirmed (cf. Allensbach, Table 33 and Bieber, '77, 33, p. 87) that the number of strong and moderate advocates of nuclear energy rose to approximately 70%, while less than one tenth of the population considered themselves opponents of the new technology. This surprising fact can be partly explained by the energy crisis in 1973 where nuclear energy was perceived as an escape from the oil dilemma. Moreover, the persons who were opponents of nuclear energy in the fifties and sixties (characteristics: conservative, advanced age, low specific know-how, fear of losing social status) failed to find a social equivalent in the new protest group against nuclear facilities (persons of younger age with university education and a more leftist political trend) and, therefore, felt insecure for political reasons. On the other hand, the protest movement was not yet strong enough to convince the potential adherents of the new innovation protest (Paschen, '78, 307, p. 5 ff.; Bieber, '77, 33, p. 85 ff.; Renn, '78, 332, p. 10 ff.).

Phase V: The characteristic feature of Phase V which started approximately with the protest activities in the German town of Wyhl (1975) was the increasing consolidation of nuclear energy opponents. Support by persons engaged in science and technology, the popular base in the local environment, the organization of citizens' initiatives and the reactions on the part of official politics which were clumsy, to say the least, had the result that more and more citizens questioned the motives of nuclear policy and adopted sceptical evaluations. Also, doubts as to the relevance of the nuclear programme were increasingly reported in the media.

Table 16: **Nuclear Energy Attitudes in the Federal Republic of Germany (Summary of Various Polls)**

Positions	1) '75	2) Jan.'76	3) Dec.'76	4) Mid '77	5) End of '77	6) May '78	7) Nov.'78
Adherents	60	39	57	59	51	39	32
Opponents	16	20	41	40	27	18	36
Indifferent	24	30	3	1	22	43	32

	8) Dec.'78	9) Apr.'79 Hesse	10) July'79 Hesse	11) July'79	12) Aug.'79	13) Jan.'80	14) June'80
Adherents	40	50	61	52	37	56	67
Opponents	39	33	22	30	48	42	32
Indifferent	21	12	17	18	15	2	2

1) Quoted from D. Goerke (Goerke, '75, 131, p. I112)
2) Infas study, FRG, No. 1315, 1976
3) Sample Institut, Hamburg, source: letter to "Deutsches Atomforum", dated 4.2.77
4) Intermarket poll, source: Kernzeitung, New Information on Energy and Energy Policy, published by the Informationskreis Kernenergie, only edition, Bonn 1977
5) Spiegel poll: Do We Need Nuclear Power? (Brauchen wir Atomkaft?), No. 8, Hamburg '77, p. 163
6) DIGOE Marketing Service, Vechta, May '78 (Goerke, '78 ..., p. 133)
7) Infra-Test, FRG, Nov. '78
8) Stern, 17.07.79
9) Frankfurter Rundschau, 16.08.79, Infas-Hessen
10) Same as footnote 9
11) Same as footnote 8
12) Frankfurter Allgemeine Zeitung, 8.08.79, Forschungsgruppe Wahlen, Mannheim
13) Der Spiegel, No. 19/1980, p. 44
14) Emnid 1980

The discussion of the hazards of nuclear energy and some apocalyptic scenarios published by sceptics created a high potential of active resistance in the local environment of planned nuclear energy facilities which was discharged in massive demonstrations and sometimes even militant activities (Brokdorf, Stade, Kalkar). On the interregional level, the symbolic notion of nuclear energy for the environmentalist movement and for the decentralization movement - politically enriched by the Nixon scandal in the United States - developed further, and a lively exchange of activists in the new antinuclear power movement was initiated. Among the public this resulted in an increased perception of nuclear energy opponents who were regarded as being a majority.

During this phase, a structurized attitude formed in most individuals; approximately 25% were clear-cut opponents, approximately 30% adherents, and the remaining 45% were ambivalent between the two extremes depending on the issues of the day and the political mood. Only a small proportion of not more than 10% were really indifferent (cf. Table 16; Scharioth, Krebsbach, '77, 382, p. 3; Paschen, '78, 307, p. 6 ff.; Renn, '78, 332, p. 108).

Phase VI: While the years from 1975 to 1978 were characterized by confrontation between opponents and adherents and the resulting polarization of views, the beginning of the Iran crisis and the Three Mile Island accident marked a trend toward less denunciation in the conflict and more attempts to find solutions that would allow political compromise. However, this should not be misunderstood as a levelling of positions. The fronts had neither softened, nor had they approached each other, but the conflicts had lost in virulence (partly due to lack of an opportunity), and both camps were undergoing an internal consolidation process to develop new arguments and new ideas for future conflicts.

In the general public, the opinion structures which had developed in the mid-seventies were more or less retained. Following a brief opinion slump after Three Mile Island, an increasingly positive basic attitude in the question as to the necessity of nuclear energy developed again among the population. However, a number of contradictory results were obtained especially at the end of 1979 (for instance, between Infas and Studiengruppe Wahlen of Mannheim). An interesting feature in this conjunction was the increasingly critical evaluation of the safety of nuclear facilities and their engineering maturity (reactions to the Three Mile Island accident) and the increasingly positive evaluation of their economic necessity.

With this background on the social development of the nuclear energy conflict, the data acquired in our studies can be better classified and understood. This empirical study to determine nuclear energy attitudes was carried out on the basis of population samples of five towns during the period from March to September 1979. These towns were selected using the following criteria:

- regional comparability (all towns are located in the same federal state);
- experience with nuclear facilities or confrontation with the planned construction of such a facility (however, the fifth town has no relationship to nuclear energy and was included as the control).

Table 17, below, lists the data for the population's nuclear energy attitude. The indicator for the interview subject's attitude was his declared intention to vote pro- or contra- at a referendum on further utilization of nuclear energy.

With the exception of Hamm, the majority in all five survey units was in favour of continuing the construction of nuclear facilities; about one third was in favour of a construction stop, and one fifth would either not go to vote or was still undecided. Significant differences are found between the values for Hamm (many opponents) and the other towns, and between Jülich (particularly few opponents) and the other towns.

Little change in these basic relations is noted when the interview subjects are asked for their attitude toward nuclear facilities, or the planned construction of such facilities, in the vicinity of their homes. The correlation coefficient between voting behaviour in a referendum and a specific vote on a nuclear facility located close to the subjects' home is 0.68 (gamma coefficient). The high level of agreement in the frequency distribution between these two variables may be considered evidence that a mentality which would approve nuclear power stations as long as they are not built in one's own vicinity, is not typical for the repondents under study.

Table 17: Voting Behaviour in a Nuclear Energy Referendum

Municipalities Characteristics	All survey areas	Kerpen Control town	Jülich Nuclear research facility	Beverungen Nuclear power station	Hamm Nuclear power station under construction	Kalkar Fast breeder under construction	n
Continued construction of nuclear facilities	46	51	58	44	31	47	232
Construction stop for nuclear facilities	33	37	21	35	39	30	166
Undecided	16	9	15	18	25	16	80
Would not go to vote	5	3	6	2	5	7	25
n	503	120	100	99	100	84	503

This correspondence between general attitude and local preference may be due to the fact that nuclear facilities already exist in four of these five survey areas, or that construction is in progress there, so that the existing reality has established a link between nuclear power stations in general and facilities located in the vicinity of the interview subjects' home.

But the same parallelism of these two variables found in the present study was just as great for the control town of Kerpen (Spearman correlation index = 0.57) so that additional justification exists for speaking of a parallel trend in the evaluation of nuclear power stations far removed and close to one's home. This interpretation is further supported by the fact that, in a previous study, this author found a comparably high correlation between these two variables (Renn, '77, 331, p.50). The perception of the necessity of nuclear power facilities and the appreciation that this might affect one's own way of life, would,therefore,not appear to be contradictory.

Effect of the Three Mile Island Reactor Accident on the Population

The most serious accident to date in the history of the peaceful use of nuclear energy, at least in the Western World, occurred on 28 March 1979 at the Three Mile Island Nuclear Power Station near Harrisburg, Pennsylvania (Kemeny Report, German edition, '80, 415, p. 18). This accident was initiated by mechanical malfunctions in the reactor and severely aggravated by a series of human errors made in attempts to correct these malfunctions. For days there were conflicting opinions as to whether an explosive oxygen-hydrogen mixture had developed and whether there was imminent danger to the population from explosions or from the emission of radioactive gases. Pregnant women were evacuated as a precautionary measure; thousands of citizens departed voluntarily from the area. Hardly any technological accident has ever triggered as broad a mass effect in the media as the Harrisburg accident. It is not the purpose of this study to describe or analyze the causes and consequences of this accident; rather, its object is to describe the reactions of the population to the Harrisburg accident. For this purpose, a description of the international reactions appears indicated first (cf. Table 18, below).

Table 18: National Surveys on the Harrisburg Effect (in percent)

Attitudes on nuclear energy after the Harrisburg accident	USA CBS Poll 1)		USA Harris Poll 2)		Sweden Zetterberg, p.19 3)		France SOFRES 4)		Federal Republic of Germany Allensbach 5)	
	1977	Apr '79	Oct'78	Apr'79	Jan'79	May'79	Mar'78	Apr'79	Feb/Mar'79	Apr'79
Adherents	69	46	57	47	41	35	47	44	37	30
Moderate Adherents +)									39	37
Opponents	21	41	31	45	43	46	42	44	12	24
Undecided	10	13	12	8	16	19	11	12	12	9

+) Continue to operate existing facilities.

1) Source: Barrados, '79, 479, p.3

2) Kernpunkte No. 22, 26.05.79

3) Zetterberg, '79, 470, p.19

4) ATW, 3 March '79; Le Monde, 5 May '79

5) Allensbach, '79

In the United States and Sweden (but also in The Netherlands and Spain), there was a clearly negative shift in public opinion, while the drop in France and in the Federal Republic of Germany (but also in the United Kingdom and Switzerland) was limited and was recovered again in the course of the subsequent months. These different types of reaction to the Three Mile Island accident have not yet been given a theoretical explanation framework.
The present study might yield some indications as to why the Three Mile Island accident caused such different reactions in different parts of the World. Due to the time phasing of the interviews conducted in Jülich the effect of this accident could be determined through comparison of the numerical data acquired prior to and after 28 March and, at the same time, several questions on the effects of the Three Mile Island accident were included in questionnaire No. III. The direct comparison shall be discussed first:

Table 19: Three Mile Island Effect: Comparison of the Values for Nuclear Energy Attitudes Prior to and After the Accident (Jülich only)

Attitude	Percentages prior to the accident	Percentages after the accident
Pro nuclear energy	6.0	4.1
Slightly positive	34.0	20.4
Neutral	28.0	38.8
Slightly negative	20.0	22.4
Negative	12.0	14.3
n	50	49

Sig. = 0.151

Lambda = 0.13

Following the general trend in the Federal Republic of Germany, the purely quantitative effect of the Three Mile Island accident was relatively low in Jülich. Considering the small number of cases, the relation is not even significant. An interesting feature of this distribution is the relatively great rigidity of the extreme attitudes and the greater migration from the moderately positive to the neutral attitude. This impression becomes even stronger when the values for the direct question as to the effect of the Three Mile Island accident are consulted.

Table 20: Reactions to the Three Mile Island Accident (in percent)

Effects of the accident	all towns	Kerpen	Jülich	Beverungen	Hamm	Kalkar
Positive attitude confirmed	1	3	0	1	1	2
Opinion not influenced	22	19	21	26	18	27
Merely stimulated interest	33	36	39	30	34	21
Slightly more negative attitude	27	27	31	21	28	25
Much more negative attitude	8	8	3	9	6	12
Previously negative attitude confirmed	10	6	6	12	12	12
Median	3.3	3.3	3.3	3.3	3.4	3.4

In the case of more than 55 percent of the interview subjects the Three Mile Island accident did not have any attitude-modifying effect; almost every third interview subject stated a slightly more negative attitude, and only one out of twelve subjects felt that this accident had caused a major attitude change. Again, marginal effects between neighboring forms of an attitude are found more frequently than a complete deviation from a previously held opinion.

In addition, subdivision of the reactions between nuclear energy adherents and opponents allows an estimate of the quantitative effects of the opinion change. Approximately 10 % of the opponents stated that the accident had induced in them a much more negative attitude toward nuclear energy. The data for the national poll conducted by the Institut für Demoskopie in Allensbach are in the same order of magnitude. A more detailed study of our survey data revealed, moreover, that interview subjects claiming a large shift of attitude after the reactor accident gave especially inconsistent replies, had not developed a very strong position and exhibited below-average values on the knowledge scale. This leads to the natural assumption that persons who were concerned only marginally with the nuclear energy topic prior to the Three Mile Island accident developed especially critical attitudes toward nuclear energy as a result of the extensive reporting on the accident without, however, having developed the strength of argument to support this opinion. The subsequent polls showed that, over time, some of the negative shift in the attitude of these persons was eliminated again. Interview subjects who had already developed a positive or negative attitude prior to the accident were given only slight cause to doubt their basic attitudes. However, this evaluation of the Three Mile Island accident applies only to the general attitude on nuclear energy, not to the evaluation of the nuclear energy risk, where the available data indicate a greater shift towards negative evaluations.

On the whole, the results of data analysis can be summarized to the effect that the variable consolidation of attitudes was responsible for the intensity of the Three Mile Island effect and that it failed to influence firmly established decisions on nuclear energy (invaccination effect), but that it did influence elements of these attitudes (such as the risk appreciation). In response to the Three Mile Island accident the nuclear energy community frequently argues that the special safety precautions taken in German nuclear power stations are perceived even by the public to be so exemplary that accidents of the Three Mile Island type could not occur in this country. This hypothesis, too, was tested in the survey. In Würgassen, Hamm and Kalkar the nuclear power stations existing or in the process of construction were used for comparison, and in Jülich and Kerpen the German nuclear power stations on the whole.

The results of these interviews showed that most interview subjects evaluated the safety of German nuclear power stations to be neither poorer nor better than the safety of the American reactor on Three Mile Island. Almost half the interview subjects felt that an accident of the Three Mile Island type would be highly improbable in this country, but still possible. About 40 % even believed that such an accident could occur in Germany at any time.

On the whole, there was no evidence of a greater confidence in German nuclear power stations. More than three quarters of the interview subjects were convinced that accidents of the Three Mile Island type could also occur in the Federal Republic of Germany. Consequently, a perception of better safety in German facilities could not have been the cause for the minor shift of opinion after the Harrisburg accident. This lends further weight to the hypothesis of a high degree of consolidation of attitudes which cannot be upset by stressing events.

Nuclear Energy Compared to Other Energy Sources

The estimation of nuclear energy as a risk source can best be measured by the evaluation given to this energy source in comparison to alternative sources. The literature contains a number of contradictory results on this topic:

- Maderthaner et al. in 1975 conducted a survey of 148 persons in Austria, including persons residing in the vicinity of reactor facilities, where the subjects were asked which of the following technological, industrial or social facilities involved the highest risk rate: a gasworks, a district heating system, an oil refinery, a psychiatric hospital, a nuclear reactor, a prison or an airport. The readiness of the interview subjects to move into the vicinity of one of these facilities or to accept its establishment in their neighborhood was evaluated as an indicator of intuitive risk assessment. Nuclear energy obtained the poorest rating among all seven risk sources. Compared to the other facilities it was perceived and evaluated as the (relatively) most dangerous and least desirable risk source. Factor analysis revealed two risk types: hazard source due to technological equipment and due to imaginability of hazardous consequences (Maderthaner et al., '76, 236).

- Unlike this study, a sampling survey conducted in 1976 in the Federal Republic of Germany revealed precisely the opposite ranking order in the evaluation of risk sources: 54 % of the interview subjects would prefer to move to the vicinity of a nuclear power station, 24 % to the vicinity of a coal-fired power station and 22 % to the vicinity of an oil-fired power station. Other risk sources were not included (Goerke, '76, 131, Part II, p.7).

- A survey conducted by the Battelle Institute in different locations in the Federal Republic of Germany where a power station was in existence, under construction or in the planning phase, revealed a still more differentiated pattern. At the outset of this study in 1975 the prevailing opinion was that, in the future, nuclear power stations should receive support with preference over all other energy sources. Throughout 1976 the vote in favour of nuclear energy declined significantly. Compared to other energy sources such as oil, coal, gas and solar energy, an especially high risk was attributed to nuclear energy. Oil and nuclear energy were given approximately equal evaluations only in one city (Mannheim). In all other locations, nuclear energy always ranked last (Battelle, '76, 25, p. A74ff).

- In a survey conducted by this author in 1977, nuclear energy held the next-to-last rank when once again investigating neighborhood preferences. Popularity ranking: machinery-making plant (27 %), motorway (21 %), coal-fired power station (20 %), nuclear power station (18 %) and chemical plant (11 %). In the same study, nuclear energy was evaluated as being especially important for the future, compared to the other energy sources, i.e. oil, gas, solar energy and coal, but at the same time it was associated with an extremely high dislike (Renn, '77, 331, p.56ff).

- In another survey conducted in 1978, a coal-fired power station was also more popular as a neighbour than a nuclear power station (42 % in favour of coal, 34 % in favour of nuclear energy). However, this survey also revealed that residents with long years of habituation to nuclear energy facilities preferred them on average, while the majority of citizens living in towns with coal-fired power stations would prefer to have nuclear energy facilities in their home towns (Goerke, '78, 132, p.93f).

The present study confirmed the trend toward an increasingly negative perception of nuclear energy, compared to its alternatives. Coal- and oil-fired power stations were preferred by most interview subjects. Also, nuclear energy exhibited a high polarizing effect: one out of three subjects selected it first, and about 40 % last. A similar effect can be shown for oil-fired power stations.

However, the question as to the undesirable neighborhood of energy-producing systems provides very little information on general acceptance. This variable correlates with the aggregate belief scale on nuclear energy only with a factor of 0.17 (sig. = 0.02) and with the general nuclear energy evaluation variable only with a factor of 0.21 (sig. = 0.00). And with the potential voting behaviour in a nuclear energy referendum this variable has a correlation of only 0.11 (sig. = 0.04). Consequently, a preference for coal and oil does not yet mean that nuclear energy is rejected. Rather, this preference merely means than most interview subjects when given a choice as to whether they would prefer coal-fired, oil-fired or nuclear power stations within the limits of their community, gave nuclear energy the lowest rating.

Better than from the mere evaluation of energy sources, preferences for energy systems can be determined from the energy option selected by the interview subjects from several given possibilities for a longer forecasting period (in the present case, the year 2000). The interview subjects were requested to state a personal preference sequence of four different energy strategies for the future of energy supply. This resulted in the following values:

Table 21: Priorities of the Desired Options (in percent)

Options	First	Second	Third	Fourth
Solar energy / alternative energy sources	35	28	23	14
Coal energy	19	29	28	23
Energy conservation	21	27	27	26
Nuclear energy	25	16	22	37

Compared to the three other energy options for the future, nuclear energy ranks last, as it did in the question of neighborhood preferences. The advocates of nuclear energy predominantly assign it the first or second place while almost all the opponents place it last.

The correlation coefficient between voting preference in a nuclear energy referendum and the priority vote for possible energy options is 0.67 (gamma). The correlation with the belief scale (eta = 0.62) and with the evaluation of nuclear energy on the basis of a semantic differential is on the same level. This relation is illustrated in Fig. 25..

This close correlation between attitude-forming parameters such as belief system and general evaluation of nuclear energy with the desired future energy supply strategy could have been expected. But it is a surprising fact that energy system preferences undergo a major shift when the interview subjects are not questioned as to their personal preferences but as to the real developments. Table 22 clearly indicates this shift in favour of nuclear energy.

This inversion of order between personal preferences and options considered realistic indicates a gulf between the beliefs held by individuals as to what their future should be like, and their expectation as to what it will actually be like. More than half the interview subjects were convinced that nuclear energy will have become the most important energy source by the year 2000, but only 19.5 % would welcome this development. This contrast between preference and perceived reality is demonstrated in Fig. 26. In keeping with this estimate of real developments there is also a majority belief that most of the electric power will be generated from nuclear energy by the year 2000. A total of 65 % of the interview subjects attribute first place in this energy sector to nuclear energy, 15% believe in the priority of coal, and only 12 % believe that solar energy and other alternative energy sources will hold first place. At the same time, most of the interview subjects were quite aware that only a very small portion of our present-day electric power is generated from nuclear energy so that, obviously, nuclear energy must be expanded in order to assume its predicted dominant position in the future energy supply.

Table 22: Priorities of the Expected Options (in percent)

Options	First	Second	Third	Fourth
Nuclear energy	52	20	18	9
Coal energy	32	39	19	10
Energy conservation	12	25	35	28
Solar energy / alternative energy sources	5	16	28	53

The results obtained in the present study clearly show that perceived future prospects and individual preferences as to the shape of the future are certainly not identical magnitudes but may even be diametrically opposed. This in percent

Belief-Scale
Semantic Differential

Nuclear Energy Last Place | Third Place | Second Place | First Place

Rank Order of Nuclear Energy Compared to the Preference for Coal, Solar Energy and Energy Saving

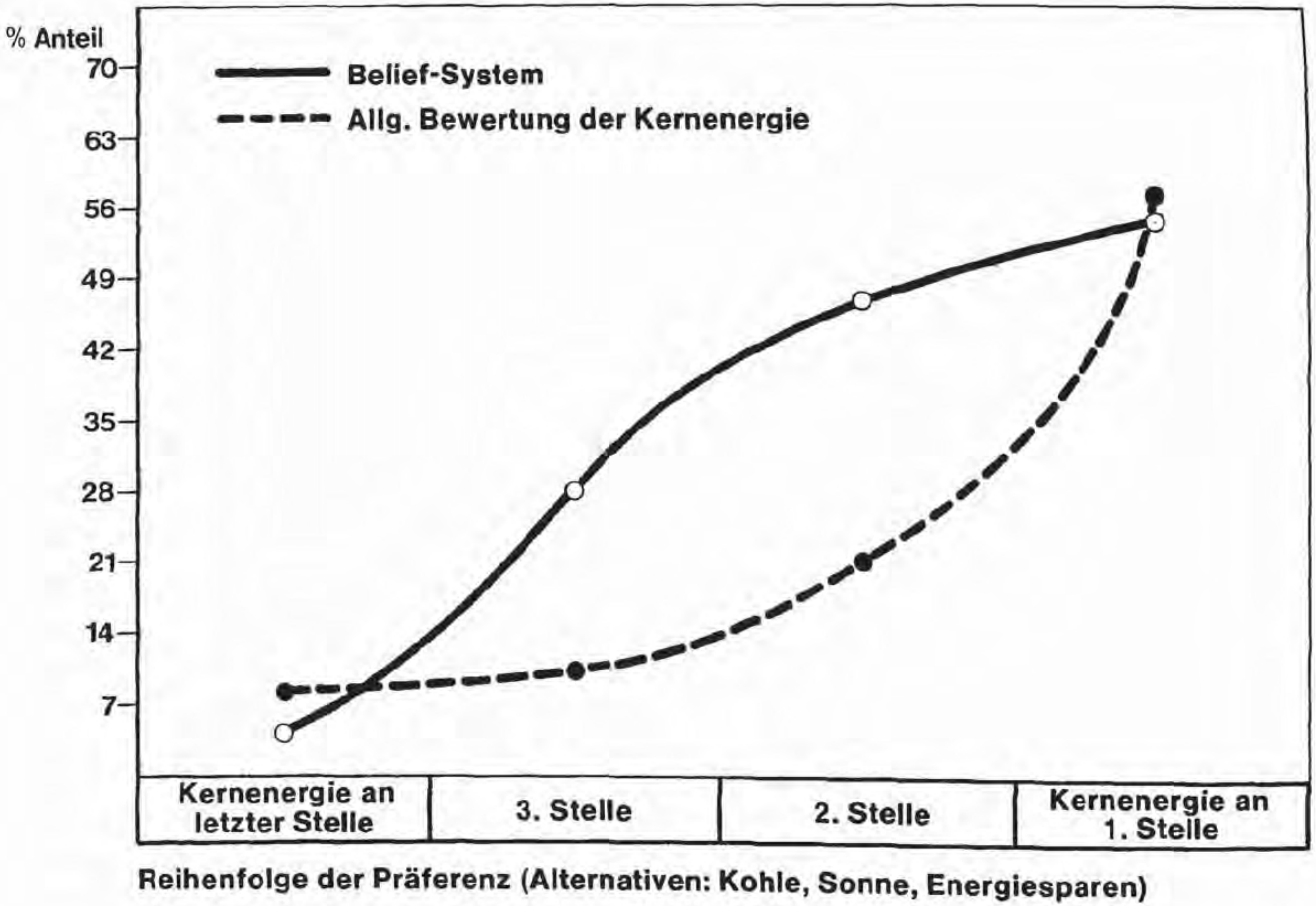


Fig. 25: Estimation of Nuclear Energy as a Personal Preference for the Future, as a Function of the Belief System and the Semantic Differential for Nuclear Energy

First Priority

First Order

Last Priority

Last Order

Nuclear Energy

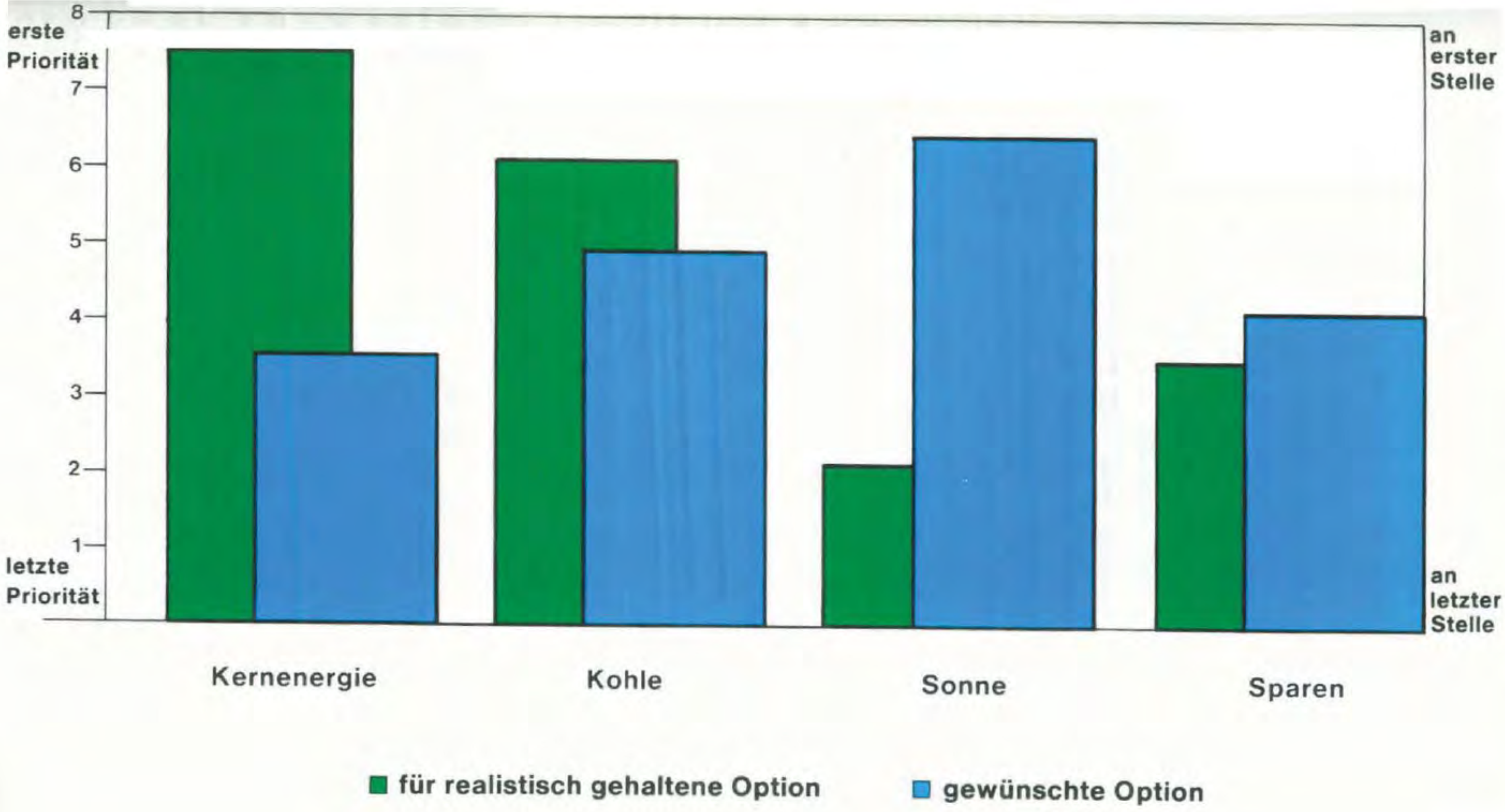
Coal

Solar Energy

Energy Saving

As Realistic Perceived Energy Option

Desired Energy Option



'ig. 26: Discrepancy Between Desired and Expected Future of Nuclear Energy contradiction is not without relevance for the political acceptance of nuclear energy. The greater the conviction on the part of the populace that their future way of life is being shaped against their will and without any possibility of exerting personal influence, the sooner we can expect political apathy and resignation as well as a retreat into sub-cultures or violent revolt. Anyone who would believe that the climax of the nuclear energy conflict has been passed already (Röthlein, '79, 339) misjudges the explosive force of a development where the gulf between desired future living conditions and perceived reality widens continuously.

Another question which concerned the allocation for research grants for energy systems in a fictitious budget of the Federal Ministry of Research and Technology must also be seen under this aspect. The interview subjects were requested to assume the Research Minister's role and allocate the funds for the support of different energy options in accordance with their own preferences.

Table 23a: Percentage Allocation in a Fictitious Energy Research Budget

Energy research grants	Percentage allocations						
	0	1-10	11-20	21-30	31-50	51-70	71-100
Nuclear energy	13	11	9	31	16	8	12
Fusion energy	38	15	32	9	1	4	1
Solar energy	0	16	39	34	5	1	5
Wind energy etc.	4	7	51	36	2	0	0
Energy conserv.	11	22	46	14	2	2	3
Coal liqu. and gasification	0	6	27	54	10	3	0

Table 23b: Mean Values of a Fictitious Energy Research Budget (in percent of the whole budget)

Energy research grants	All respondents	Advocates	Opponents
Nuclear energy	27.4	30.0	21.4
Fusion energy	15.8	15.3	13.3
Solar energy	20.1	17.8	25.0
Wind energy etc.	20.9	17.3	23.5
Energy conservation	18.5	17.2	21.3
Coal liqu. and gasification	21.4	20.2	22.0

The response pattern in this imaginary budget planning of research projects lies in the middle between the personal preference for a future energy option and the development considered to be realistic. The interview subjects had to abstract themselves from their own person and perform the public function of a federal minister. The phrasing of these questions, however, emphasized the minister's policy-making authority to allocate the budget according to his own judgement. It is not surprising, therefore, that the values range between the extremes of personal preference and forecast future.

With the exception of fusion energy, which meant little to the interview subjects, the percentages of the remaining energy sources range in close proximity. The values for coal liquefaction and gasification, solar energy and wind energy do not differ significantly. This applies especially to nuclear energy opponents who allocated 20 % of the research budget to each variant, with the exception of solar energy.

The poisoned water experiment had already revealed that personal risk-taking decisions are influenced by a subject's role as a public servant. And so it is possible that nuclear energy opponents, forced into the research minister's role, abandon personal preferences in favour of an overall approach and allocate support to nuclear energy, for instance , for economic reasons. However, the gulf which is revealed between personal preference and perceived development is more likely to be the result of a compensatory attitude in that nuclear energy opponents feel that it is already too late to do anything against the nuclear programme. So they would allocate financial support to nuclear energy in order to optimize through research the safety aspects of a development which can no longer be stopped. It is likely that, in this case, the two explanation patterns overlap.

In addition, subdivision of the percentage values into classes reveals an interesting pattern of association with extreme values (cf. Table 23a). Apart from fusion energy which was included only because many well-informed interview subjects in the pretests had criticised its absence, nuclear energy exhibited a greater fringe distribution than all other energy variants. The high degree of polarization in the nuclear energy debate has induced a number of persons to assume extreme positions which exhibit almost identical numbers at either end of the opinion scale.

However, total rejection of nuclear energy does not imply total advocacy of solar or wind energy; nor does extreme adherence to nuclear energy imply total rejection of alternative energy sources. Coal liquefaction and gasification and energy conservation do not even differ significantly in the contemplated research budgets suggested by opponents and adherents of nuclear energy (sig. = 0.34 and 0.11, respectively).

The different distribution values for nuclear energy in comparison to the remaining variants of energy production can be still further differentiated by including the semantic differential for the different alternatives in the analysis.

Such a differential has been plotted in Fig. 27 for coal, nuclear energy and solar energy. The three curves demonstrate that solar energy is given highly positive evaluations in all categories and that coal is also given a positive evaluation under general and analogous terms, with negative judgements only under the pollution and resource waste aspects. However, nuclear energy is regarded positively only in the categories of scientific and modern, while it is negatively perceived in all other categories.

1. sympathatic	unsympathatic
2. important	unimportant
3. right	wrong
4. useful	harmful
5. safe	dangerous
6. liberating	suppressive
7. good	bad
8. modern	old-fashioned
9. clean	dirty
10. unrisky*	risky
11. acceptable	unacceptable
12. familiar	uncanny
13. natural	unnatural
14. human	inhuman
15. environmentally protective	environmentally harmfull
16. powerful	powerless
17. scientific	unscientific
18. moral	immoral
19. economical	uneconomical
20. reliable	unreliable

Nuclear Energy
Coal
Solar Energy

Unrisky has a slightly different connotation in German than the English word 'safe'

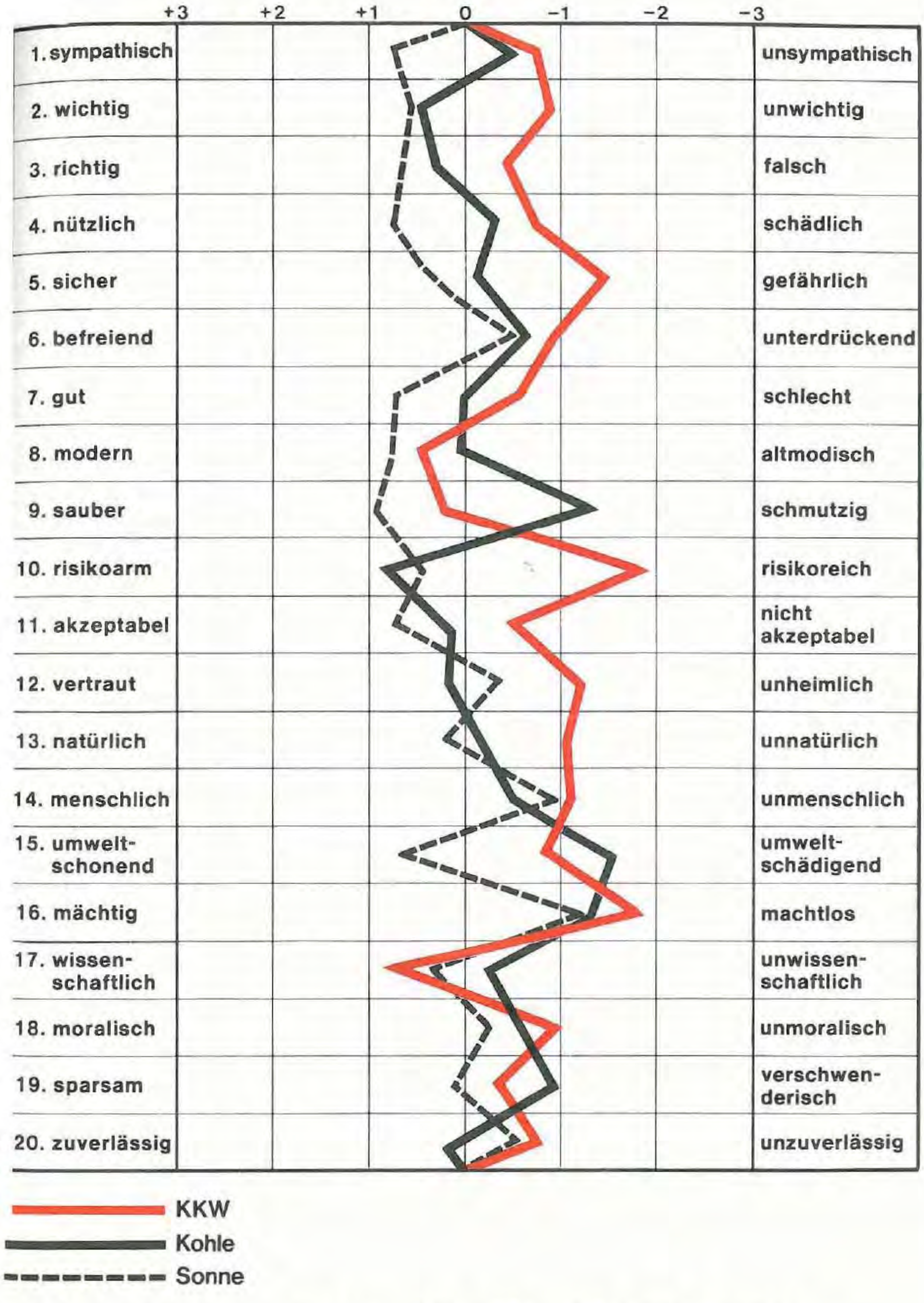


Fig. 27: Attributive Profiles for Coal, Solar and Nuclear Energy (Semantic Differentials)

Differentiation between nuclear energy opponents and adherents reveals clear-cut differences in response behaviour for the nuclear energy profile, but hardly any differences in the profiles for solar energy and coal. The independence of the nuclear energy attitude from opinions on alternative energy sources must lead to the conclusion that both opponents and adherents intuitively prefer the alternative energy production systems. However, the adherents (for reasons not yet clarified) believe that we connot do without nuclear energy, and some of them defend this position with extreme rigidity. The opponents, on the other hand, believe that we could live without nuclear energy but feel that this opinion is politically unrealistic.

Attitudes Toward Nuclear Energy and their Internal Structure

In the theoretical part of this study the attitude concept was clarified as a mental relationship to an object or class of objects which is composed as a combination of general beliefs weighted with their subjectively perceived probabilities,of affective evaluations and finally of behavioural intentions. Special value was attributed to the cognitive component, i.e. the belief system for the object in question. In order to cover completely the entire spectrum of these aspects, the following questions were selected for the interviews:

- Free associations on nuclear energy;
- A scale of 13 items to measure beliefs and arguments (belief scale);
- A knowledge scale of nine items;
- A question to determine the interview subject's self-evaluation of his information level;
- A question aimed at the estimated information level of other citizens;

- A positive bias scale comprising 3 items of the knowledge scale;
- A negative bias scale comprising 3 items of the knowledge scale;
- Interest in the nuclear energy topics.

In the free associations on nuclear energy, negative terms such as accidents, radiation risk, harmful effects on health etc. were dominant for both opponents and adherents. The number of these negative judgements is relatively independent of the attitude toward nuclear energy or its risk estimation. The low correlation coefficient for both variables indicates that, initially, all the interview subjects associated nuclear energy with all the risks involved in it, regardless of whether these risks are considered to be very high or very low (gamma = 0.17). A detailed list of these free associations has been compiled in Table 24. This was an open-end question, and the interviewers had to classify the responses in accordance with a prescribed list of 18 categories or, when the response did not appear to fit any of these categories, report the response separately.

With respect to the estimation of the interview subjects' own level of information, more than two thirds of the subjects were convinced that they were fairly well or well informed on nuclear energy. In a 1978 poll, an average of only 40 % of the population stated they were adequately well informed (Goerke, '78, 132, p.122). However, the "adequate" category was the highest possible self-evaluation in that poll. In the survey implemented by this author in 1977, the number of persons who felt fairly well or well informed was also much lower (Renn, '77, 331, p.66). However, the two surveys agree in one respect: most individuals are sceptical with respect to the information level of other citizens. In the 1977 survey, 77.7 % and in the present 1979 survey 82 % of the interview subjects believed that most other citizens were poorly

Table 24: Free Associations on Nuclear Energy
(up to five entries per interview subject)

Associations	Absolute frequency	Percentage	Percentage of all cases
Accidents/incidents	229	10.5	45.8
Three Mile Island accident	227	10.5	43.4
Reprocessing plants (Gorleben)	173	7.9	34.6
Citizens' initiatives	129	5.9	25.8
Economical energy production	127	5.8	25.4
Modern energy production	126	5.8	25.2
Radioactivity damage	124	5.7	24.8
Demonstrations	112	5.1	22.4
Unsafeness	97	4.4	21.8
Reactor types	96	4.4	19.2
Low risk	61	2.8	12.2
Environmental degradation	59	2.7	11.8
Dependability of supply	58	2.7	11.6
Environmental pollution	56	2.6	11.2
Efficient energy production	54	2.5	10.8
Harmful effects on health	51	2.3	10.2
Environmentally clean	35	1.6	7.0
War/terrorism	31	1.4	6.2
Miscellaneous	10	0.5	2.0

or fairly poorly informed on nuclear energy topics. While the subjects' self-evaluation of their information level provides an idea of the cognitive self-confidence of the subjects, the next item of interest is a comparison between self-evaluation and the objective scale value on the knowledge index. Some numerical data shall illustrate this:

Table 25: Knowledge and Self-Evaluation of Individuals' Information Level (correlations)

Variable		Self-evaluation of information level	Evaluation of information level of other persons	Positive bias	Negative bias
Knowledge	Significance	0.00	0.00	0.07	0.02
	Correlation (eta)	0.23	- 0.17	- 0.07	- 0.14

It is seen clearly from this table that the subjective self-evaluation matches the objective knowledge level to a certain degree. However, the low correlation coefficient of 0.23 appears to indicate that many individuals overestimate or underestimate their information level.

The better the interview subjects can give correct answers on nuclear energy, the more sceptical they are with respect to the information level of other citizens. This relation is also fairly weak (eta = - 0.17) but significant. As expected, positive and negative bias exhibit a negative correlation with knowledge but the relatively low correlation coefficient indicates that individuals with high negative or positive bias reject the whole of the opposite bias and probably give the correct answers to pure knowledge questions on nuclear energy. High bias, therefore, does not necessarily imply less information on nuclear energy, but does imply unilaterally weighted knowledge.

An interesting difference compared to the 1977 survey in Kerpen deserves to be mentioned: in that town the nuclear energy advocates clearly exhibited more positive bias than the opponents exhibited negative bias. This relationship has become approximately inverted in the present study. The median for positive bias is 1.75 in the case of the adherents, and the median for negative bias on the part of the opponents is 2.21. This relationship applies to all the towns surveyed.

In addition to the positive and negative associations and the knowledge scale with the bias indices derived from it, a scale of 13 statements on nuclear energy was used to achieve a broad differentiation of nuclear energy beliefs. The numerical response categories were simply combined in a summated index. This scale is interpreted as a belief scale. Moreover, another, weighted belief scale was designed by means of unrotated factor analysis. These two indices have a correlation coefficient of 0.90 so that, as a rule, they are interchangeable.

The belief scale exhibits relatively high correlation with all cognitive variables so that, in the further analysis, it was used as being representative for the cognitive component. The emotional intensity within the attitude, used for this nuclear energy survey, was not measured by weighting the statements in accordance with Fishbein's model of the evaluation scale, as in the risk perception study, but by using a semantic differential. Based on unrotated factor analysis, the values were selected which ranked high in the general evaluation via the semantic differential, two other variables were computed which are expected to pròvide information on the strength and consistency of the overall conviction. The strength index was formed from the sum of extreme response categories for discriminatively unique attitude variables (such as belief, nuclear energy as the most-favoured option etc.). The consistency index describes the linearity of the response behaviour. The numerical value provides information as to the degree to which discriminatory questions yielded responses which matched the positions and attitudes.

Table 26: Medians for the Consistency Index and Strength Index

Variables	Arithmetic medians (Range 1 - 16)	
	Consistency	Strength
All	8.51	5.34
Adherents	8.10	5.38
Opponents	10.01	6.09
Undecided	6.30	4.13
Kerpen	8.38	4.72
Jülich	9.15	5.01
Beverungen	8.04	5.06
Hamm	8.29	5.73
Kalkar	8.76	5.79

It is obvious that nuclear energy opponents and the Jülich and Kerpen interview subjects were more consistent in their response behaviour, although most of the adherents lived in these two towns. Also, opponents exhibit less compromising attitudes in many nuclear energy topics, while the adherents and undecided subjects prefer moderate response categories. A high interest in nuclear energy topics and an adequate information level have a positive effect on the variables of consistency and strength. This tends to confirm the initial hypothesis that the cognitive stress in the case of the adherents, in this case initiated by non-consistent response behaviour and lesser attitude strength, is considerably higher than it is in the case of the opponents who, on the whole, exhibit a more homogeneous response structure. However, the most interesting result drawn from the analysis of energy options is that the opponents reveal a clear discrepancy between their own attitude and their perceived reality. This discrepancy was not noted in the case of the adherents. Thus, individuals who have developed fairly positive attitudes toward nuclear energy and take the corresponding positions, are often contradictory in their cognitive structure, meaning that their belief system may also include information which contradicts their overall attitude. But at the same time, they feel that the general development of society confirms their decision. Conversely, nuclear energy opponents consider the development toward expansion of this energy source to be an unavoidable process, but have a consistent and well-developed negative (cognitive and affective) attitude structure. This suggests the conclusion that a positive attitude toward nuclear energy is usually associated with a cognitive internal stress, and a negative attitude with an external realization stress.

The last attitude structure component to be discussed is the behavioural intention. It was already mentioned in the theoretical concept that this propensity cannot be derived from the cognitive and affective components but is only partly attributable to these two factors. In the present study, behavioural intention was measured by means of a scale which combines different statements on possible actions in the nuclear energy conflict. These statements were listed in a sequence so as to obtain an excalation of actions, starting with the collection of signatures and ending with active violence. From the values on this scale an index was computed which was labelled behavioural intention. The median values for this variable have been compiled in Table 27, below.

Table 27: Median Values for the Behavioural Intention Variable, Subdivided by Towns Surveyed and Nuclear Energy Attitudes

Arithmetic median	Range	All	Kerpen	Jülich	Beverungen
Behavioural intention	0 - 30	9.24	10.86	5.01	8.06

Median values	Hamm	Kalkar	Adherents	Opponents	Undecided
Behavioural intention	13.69	11.46	6.6	12.84	4.77

Correct interpretation of these data requires a brief explanation of the scale intervals: at a range from 0 to 30, the value zero means no commitment at all, the value 5 means readiness to sign a declaration or, possibly, go to a meeting, the value 15 includes participation in a demonstration, a scale value of 25 means that the interview subject was in favour of probable participation in a site occupation or removal from a site by the police, and the maximum of 30 means that the subject was in favour of active violence. The median value of 9.24 for the total number of interview subjects means that the majority was prepared to sign a petition pro or contra nuclear energy, to go to meetings occasionally and, possibly, to write letters to the editors of newspapers or periodicals. In Hamm and Kerpen the interview subjects were prepared to take even stronger action, while in Jülich most citizens were reluctant to translate their attitudes into concrete action. However, if the basic nuclear energy attitude is held constant, a relatively uniform distribution of behavioural intention is found in all five survey areas.

The differences in behavioural intention are revealed by the scalar medians when the positions are differentiated. The average nuclear energy adherent would sign a petition for a pro-nuclear energy campaign and would perhaps go to a meeting, but he refuses to go any further. The average opponent, however, would go beyond and would write letters to editors, and some are prepared to work for citizens' initiatives and possibly even to take part in demonstrations. The undecided individuals in a referendum could at best be induced to sign a petition pro or contra nuclear energy.

This discrepancy between adherents and opponents is still more evident when the risk-benefit estimate is included as a control parameter. The more extreme the positive or negative perception of nuclear energy as a risk source, the greater will be the propensity to take action. However, the strength of this relation is only half as great for a positive risk estimation as it is for a negative risk estimation. Fig. 28 shows this relation in graphical form.

At first glance, this confusing variety of cognitive, affective and action-relevant parameters fails to reveal any consistent pattern of relationships. However, path analysis, a statistical procedure which allows causal interpretations on the basis of the distribution of correlation coefficients, can be used to explain the basic structure of nuclear energy attitudes. The results of this path analysis have been plotted in Fig. 29 where the numerical data entered above the arrows describe the strength of each relationship.

The model is characterized by three starting points: the perception of the economic necessity of nuclear energy, knowledge of nuclear energy and the risk-benifit estimate. These three variables are not independent of each other, but their influence takes different paths. While the belief in the economic necessity of nuclear energy shows very high correlation with the position stated for a hypothetical referendum, the risk-benefit estimate influences both attitude components, the cognitive belief system and the affective evaluation. Nuclear energy knowledge has only a minor direct relationship with all of these variables. The information level affects the evaluation and the belief scale only via the circuitous route of self-evaluation and positive bias. The strength of the weighted attitude is obtained from the affective component, the stated bias and the values on the belief scale as well as, indirectly, from the consistency of the verbal responses in the questionnaire. The consistency in turn is influenced by the evaluation level. The final result, behavioural intention, is mostly due to the strength of the stated attitude and, to a lesser degree, to the position in a referendum on nuclear energy.

With respect to its content, this model can be interpreted as follows: individuals who believe in the necessity of nuclear energy for economic reasons will vote in favour of the nuclear energy source in a referendum, simulated in this study, even when they perceive a greater risk. And their preference for nuclear energy is amplified if they are convinced of having a good information level and, in addition, have a number of positive biases for nuclear energy.

The belief system, on the other hand, has a greater dependence on the perception of the risk-benefit relation. It is true that a positive risk estimation is a prerequisite for a positive attitude in a referendum;

Willingness to Take Action

Risk-Benefit Estimation

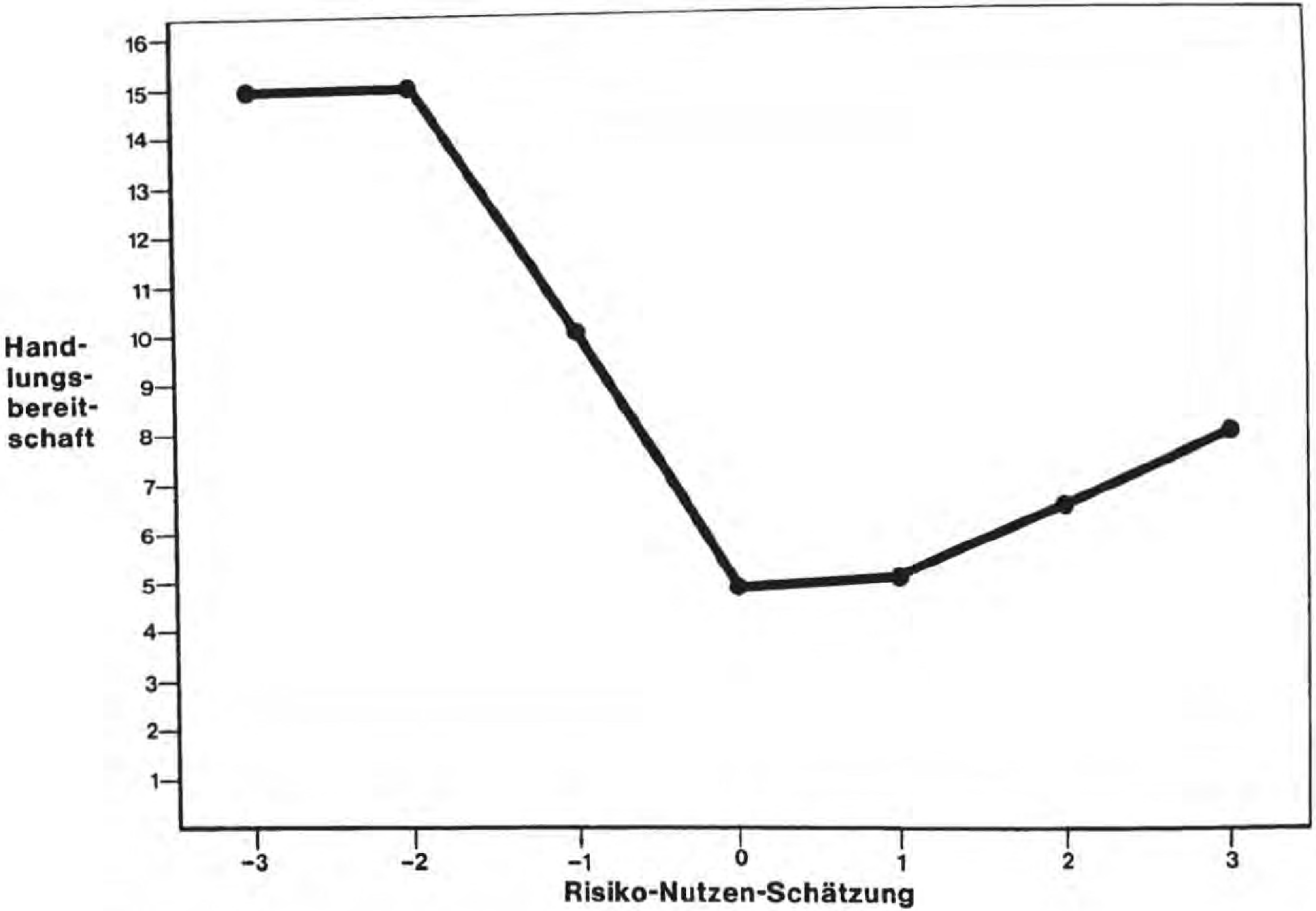


Fig. 28: Relationship Between Risk-Benefit Estimation
and Behavioural Intention

Perception of Economic Neccessity of Nuclear Energy

Position in a Referendum on Nuclear Energy

Knowledge about Nuclear Energy

Self-Perception of Own Knowledge

Positive Predujices

Strength of Attitude

Willingness to Act (Conation)

Risk-Benefit Estimation

Belief-Scale

Consistency of Attitude

Evaluation of Nuclear Energy

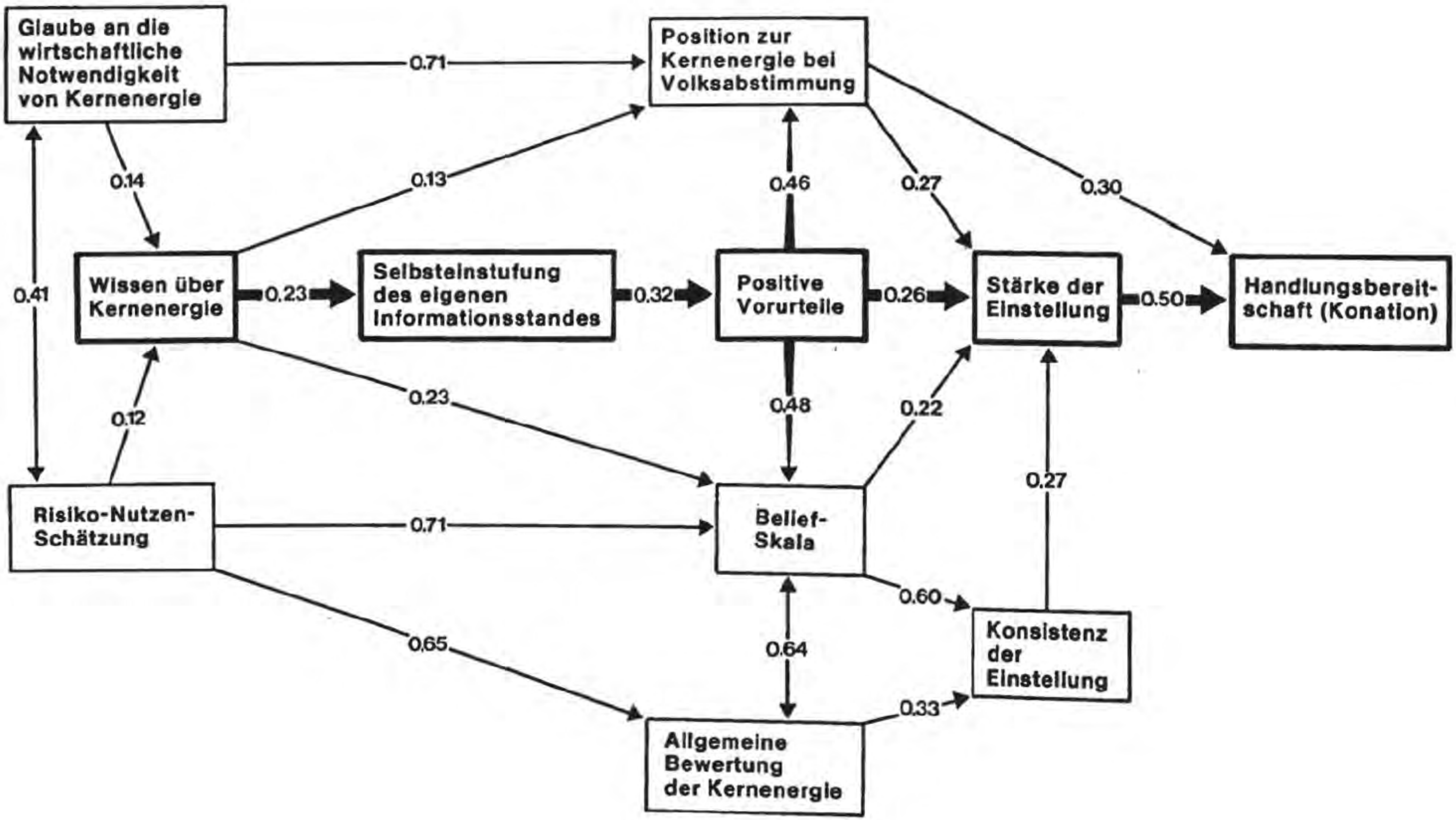


Fig. 29: Path Analysis Model of Nuclear Energy Attitudes and Position in a Referendum

however, it is possible to compensate negative values on this scale by taking the bitter pill of economic necessity, although this will not affect the general beliefs and and evaluations of nuclear energy.

When the risk and the economic necessity are both given a negative evaluation, the result is total rejection which leads to an especially strong negative attitude. At the same time, negative risk-benefit estimations and negative belief systems require a high internal consistency of the attitude-forming variables, where cognitive stress cannot even develop. The strength of an attitude, combined with the stated selection preference (pro or contra nuclear energy), can predict a large portion of the variance of the behavioural intention variable.

Moreover, polls conducted by other institutions suggest the conclusion that the attitude components acquired via risk-benefit estimations have a relatively long life, although events such as the Three Mile Island accident do have a destabilizing effect, but without causing any basic changes. The stated basic attitudes or the simulation of a referendum are dependent on the political events of the day, since the perceived degree of economic necessity varies, depending on the world-wide political situation.

The relatively high risk estimation of nuclear energy and the preference for alternative energy sources, even on the part of nuclear energy adherents, make it clear that the position calling for an expansion of nuclear energy as a future option can be maintained only if there is no doubt that the economic necessity persists in the perception field. It is likely that in times of economic crisis many individuals will vote in favour of nuclear energy although, based on their feelings and cognitive structure, they would be more likely to have a sceptical attitude toward this technology. However, the converse conclusion does not apply. Committed opponents of nuclear energy who not only perceive the risks of nuclear energy but also dispute its economic necessity will hardly become adherents of this technology even in times of crisis because they have a self-contained, consistent attitude system.

5. Significance of Personal Value Preferences and Socio-Political Beliefs for the Formation of Nuclear Energy Attitudes

In recent years an increasing shift from materialistic to post-materialistic, from quantitive to more qualitative values has been noted by social research (Inglehart, '80, 183, p. 144ff; Kmieciak, '76, 208). Although the polarity between materialist and post-materialistic attitudes is not adequate to describe the value changes which have taken place during the past decade, the trend shows that, following quantitative saturation phenomena in the consumer area, objectives aiming at more quality of life are gaining significance.

In this conjunction the thesis is often presented that the rejection of nuclear energy is a value-shift symbol and an expression of dissatisfaction with the consumer culture (Paschen, '79, 307).

And, indeed, an earlier study carried out in 1975 revealed a high correlation between the desire for restrictions to economic growth and a negative nuclear energy attitude (van Buiren, '75, 46, p.250). Subsequent studies, however, yielded a more differentiated result (Battelle II, '77, 25, p.107ff; Renn, '77, 331, p.90ff): the majority of the population attempt to take a middle course between materialistic and post-materialistic values without allocating any clearly defined priorities.

In the present study, 17 general problems of society such as unemployment, terrorism or health care, and 10 personal values such as a clean environment or harmonious family life were specified in a scale. These terms had not been selected arbitrarily but determined through open-end questions in a pretest. In the actual interviews the subjects were requested to state the urgency and importance of these problems and values. The responses mostly confirmed the results of more recent studies in this field that there is a high degree of competition between materialistic and post-materialistic values in the eyes of the population and that priorities are established in a differentiated and ambivalent manner.

Abstract problems of society such as unemployment, terrorism and inflation are classified as being serious while, at the same time, personal values such as health, clean environment and harmonious family life are estimated highly. Purely material values such as raising the standard of living or high income are more likely to be found at the bottom end of both scales. Environmentalism, an important post-materialistic value, is given the greatest urgency with respect to both society and the personal environment. Other typical categories in this area such as social justice and enjoyment of one's work, occupy intermediate positions.

Comprising factor analysis allowed plotting of the society-related and personal value beliefs in a two-factor diagram whose axes represent the degree of post-materialistic qualitative value commitment and the degree of personal involvement (cf. Fig. 30).

However, the structure of value beliefs is of little interest for the question as to nuclear energy attitudes. More significant is the relationship existing between nuclear energy attitude and value system which shall be illustrated with the aid of some correlation analyses:

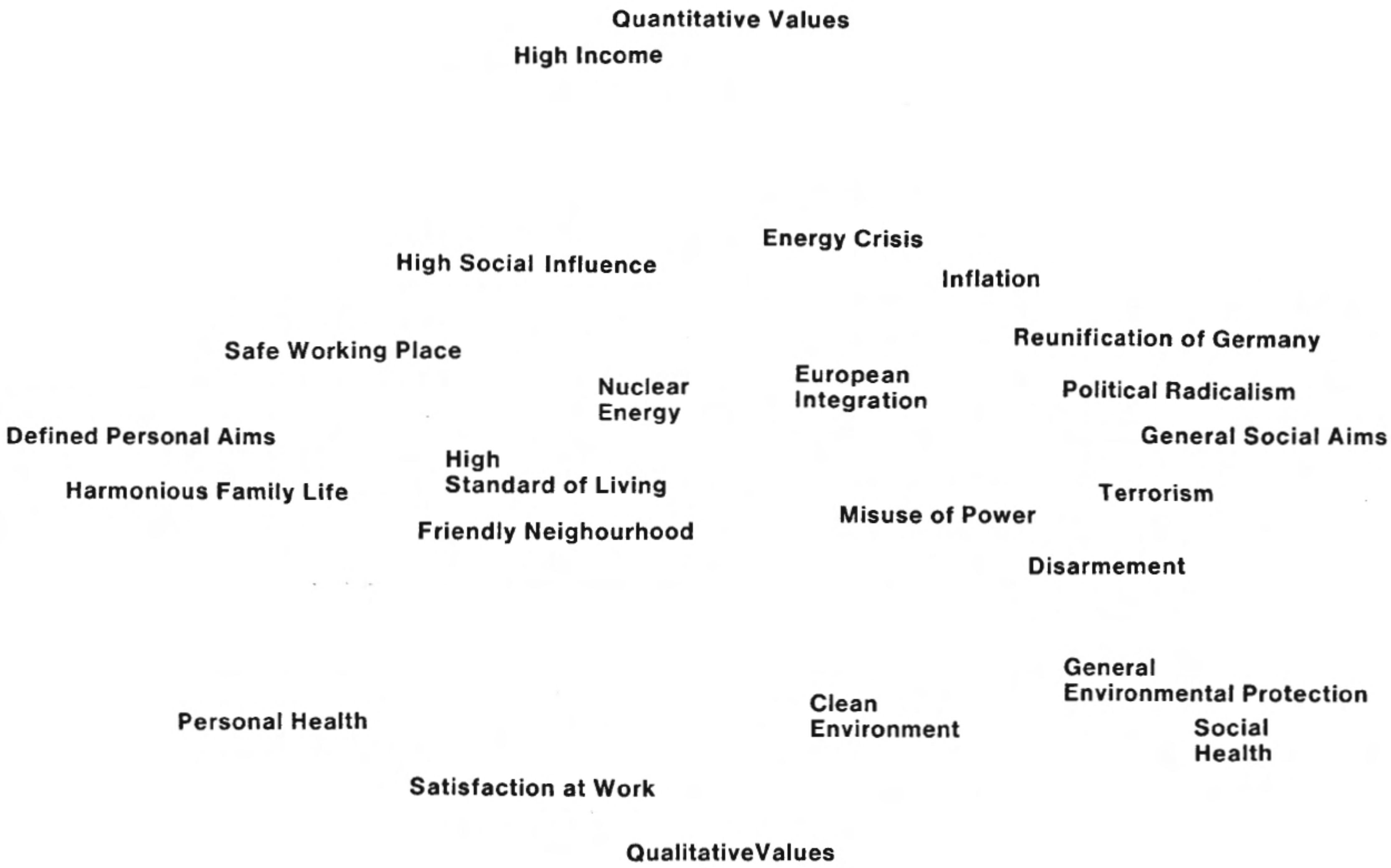
Table 28: Correlation of Nuclear Energy Attitude Components with General Value Beliefs

General problems	Position*** Sig.*	Gamma**	Belief system Sig.*	Spearman**	Affective evaluation Sig.*	Spearman**
Inflation	0.04	-0.14	0.12	-0.06	0.01	-0.10
Pollution	0.00	-0.27	0.00	-0.26	0.00	-0.23
Social justice	0.01	-0.19	0.07	-0.07	0.01	-0.11
European unity	0.04	+0.13	0.24	+0.03	0.11	+0.09
Energy crisis	0.01	-0.21	0.00	-0.18	0.00	-0.19
Nuclear energy	0.00	-0.28	0.00	-0.24	0.00	-0.21
Political radicalism	0.02	+0.15	0.03	+0.13	0.06	+0.11
Power of big business	0.05	-0.11	0.04	-0.12	0.04	-0.13
Disillusionment with the state	0.03	+0.14	0.06	+0.09	0.06	+0.10
Improvement of living standard	0.00	+0.20	0.01	+0.15	0.00	+0.16

* Significance ** Correlation coefficient
*** Position in a referendum on nuclear energy

Table 29: Correlation of Nuclear Energy Attitude Components with Personal Value Beliefs

Values	Position*** Sig.*	Gamma**	Belief system Sig.*	Spearman**	Affective evaluation Sig.*	Spearman**
Clean environment	0.00	-0.27	0.00	-0.41	0.00	-0.33
Job security	0.06	+0.09	0.13	+0.08	0.27	+0.04
Adequate standard of living	0.02	+0.13	0.00	+0.17	0.01	+0.12
Enjoyment of one's work	0.02	+0.12	0.00	+0.13	0.02	+0.11
High income	0.00	-0.28	0.00	-0.21	0.00	-0.19


Quantitative Values
High Income
Energy Crisis
High Social Influence
Inflation
Reunification of Germany
Safe Working Place
European Integration
Nuclear Energy
Political Radicalism
Defined Personal Aims
General Social Aims
High Standard of Living
Harmonious Family Life
Terrorism
Misuse of Power
Friendly Neighbourhood
Disarmement
General Environmental Protection
Clean Environment
Personal Health
Social Health
Satisfaction at Work
QualitativeValues

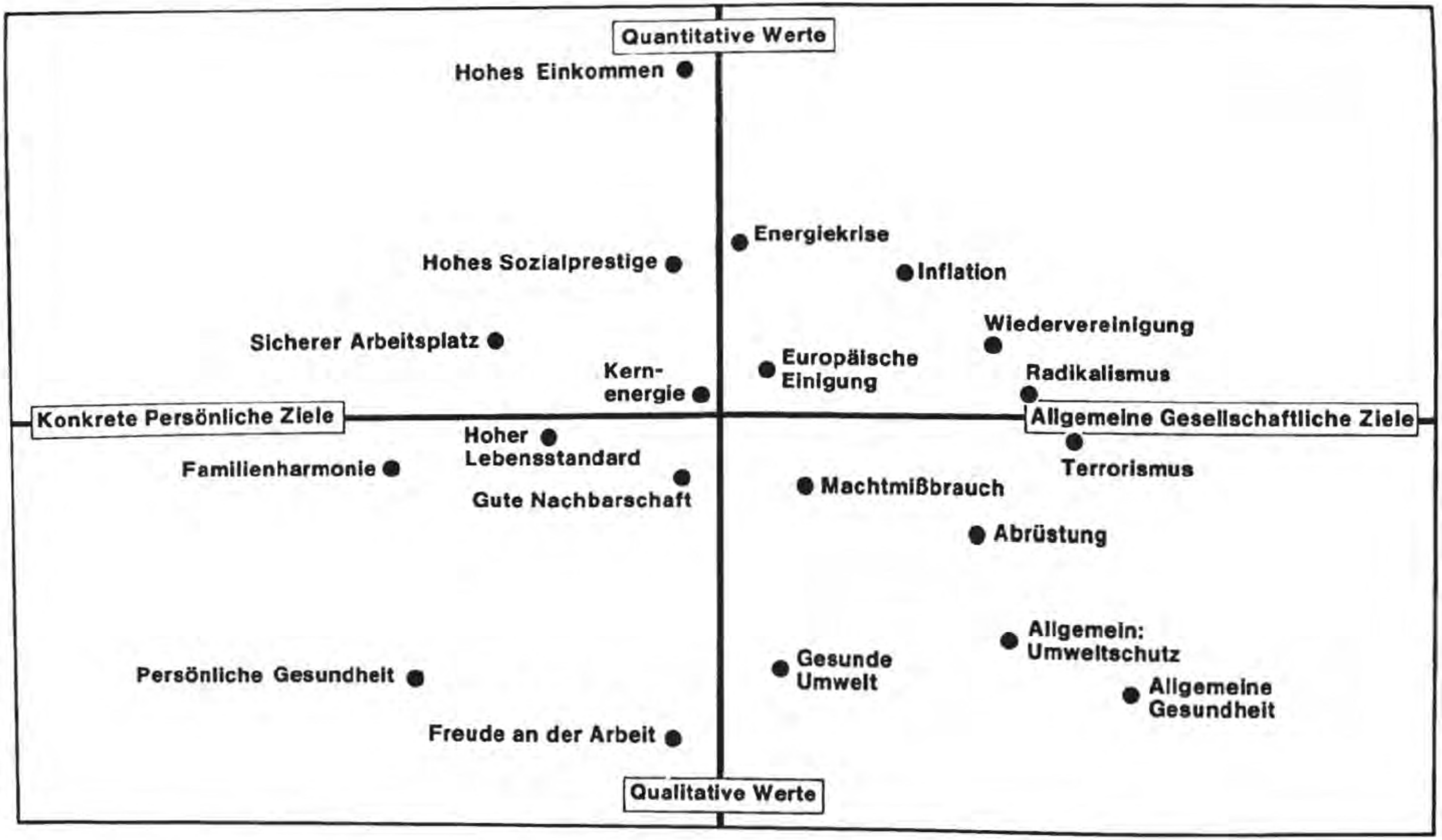


Fig. 30: Specific Pattern of General and Personal Values in a Two-Factor Psychological Space

Both tables demonstrate that the stated value beliefs with the exception of the clean environment variable have only a minor effect on nuclear energy positions and attitudes. Again, it is interesting to note the greater ties between economic concepts and voting behaviour in a referendum (position), and between environment- or risk-specific values and the attitude components. That the energy crisis and nuclear energy have a discriminating effect on both positions is not surprising; however, the correlation coefficient is unexpectedly low. Nuclear energy adherents prefer economically quantitative values, and nuclear energy opponents prefer post-materialistic and qualitative values, but this relationship is weak with the exception of quite obvious relations (with respect to nuclear energy and the energy crisis). The only exception is that a special preference for a clean environment has a great effect on the belief system on nuclear energy. Negative perceptions of nuclear energy are especially well-developed in those individuals who attribute special value to a clean environment. An interesting feature is that the general attitude toward the environment protection problem provides a much poorer predictive value for the nuclear energy attitude than the individualized desire for a clean environment. Quite generally, environmental protection is an important society-related problem for the adherents of nuclear energy as well.

In addition to differentiation between opponents and adherents, the category of the undecided individuals must be discussed in more detail here, since it is this group in particular which takes a pro-materialistic and pro-economic position in the survey, which would have been more in keeping with the attitude of a nuclear

energy adherent. The attitude of the undecided individuals becomes clearer if we look once again at the risk-benefit evaluation (medians: adherents +1.7, opponents -0.9 and undecided individuals -0.5). Due to their negative risk perception they cannot state a positive attitude toward nuclear energy, although this would match their economic value beliefs.
Yet, these economic beliefs prevent a complete shift to the opposite side. Of course, this dualism of negative risk estimation and positive economic evaluation does not apply to all undecided individuals; however, the medians in each case indicate that a majority of this group is involved in an inner conflict between risk evaluation and economic value-orientation. This thesis is further confirmed by the fact that, in the question as to the economic necessity of nuclear energy, the undecided individuals are much closer to the position of the adherents than to the position of the opponents (medians: adherents 2.1, undecided individuals 1.7 and opponents 0.2).

In a number of studies the close proximity of sociopolitical beliefs and nuclear energy estimations has been determined in addition to the value commitment.

In order to study this hypothesis in more detail, the following attitudes described in theoretical or empirical studies reported in the literature were measured with the aid of suitable scales:

- a confidence scale for science, politics and technology (models: Douglin, '76, 81; Goerke '78, 132);
- a conservatism scale (model: Dumenil, '77, 85);
- a participation scale (model: Douglin, '76, 81);

- a political apathy scale (model: Douglin, '76, 81; Dumenil, '77, 85);

- an environmental awareness scale (model: Gutmann, '77, 147; Douglin, '76, 81).

After appropriate pre-testing, these five scales were included in the questionnaire and subjected to another post-factum factor analysis. The five scales were then recomputed in accordance with the factor scores of each statement. The following table lists the median values for each scale:

Table 30: Socio-Political Attitudes (Arithmetic Median Values)

Scales	Range	All	Kerpen	Jülich	Beverungen	Hamm	Kalkar
Confi-dence scale	-61 to 59	+5.62	+3.8	+ 9.1	+10.9	+ 0.1	+ 6.5
Conserva-tism scale	-58 to 69	+27.9	+31.0	+29.6	+25.9	+29.4	+31.5
Partici-pation scale	-30 to 55	+28.6	+28.5	+23.5	+32.2	+33.7	+25.8
Political apathy scale	-58 to 46	-22.7	-27.7	-17.9	-29.2	-19.6	-23.1
Environ-mentalism scale	-34 to 56	+16.9	+15.0	+10.6	+15.1	+24.0	+15.4

More decisive than the breakdown by towns is the question as to the ratio of these variables to the positions and attitude components with respect to nuclear energy. Since the individual scales are not independent of each other, a multiple regression procedure was selected for evaluation, meaning that the common effect of the individual values on the dependent variables was estimated.

The results of this regression analysis have been compiled in Table 31, below:

Table 31: Multiple Regression Analysis of Socio-Political Attitudes with the Belief System (Belief Scale)

Independent variables	R Multiple correlation	R^2 Declared variance	r Simple correlation	Significance
1. Confidence scale	0.49	0.24	0.49	0.00
2. Environmentalism scale	0.56	0.31	0.35	0.00
3. Participation scale	0.60	0.36	0.41	0.00
4. Conservatism scale	0.62	0.38	0.29	0.03
5. Political apathy scale	0.63	0.39	0.41	0.02

Consequently, almost 40% of the belief system's variance can be explained by the combined effects of these five scales. Of special significance are confidence in science and technology and the strength of environmental awareness. In addition, the desire for participation has an amplifying effect on a negative nuclear energy evaluation.

The magnitude of the correlation values quite supports the assumptions that general socio-political attitudes are significant for nuclear energy perception. These findings are also supported by the high correlation values with the risk-benefit estimates. All five relationships to this variable have been plotted in Figure 31.

Consequently, low confidence in the statements of scientists and technologists, combined with a high priority for environmental protection mean a more negative nuclear energy risk perception from the outset.

(%)

Confidence in Science and Technology

Anti-Fatalistic Point of View

Tendency toward Conservative Social Values

Environmental Awareness

Desire for Participation

Risk-Benefit Estimation

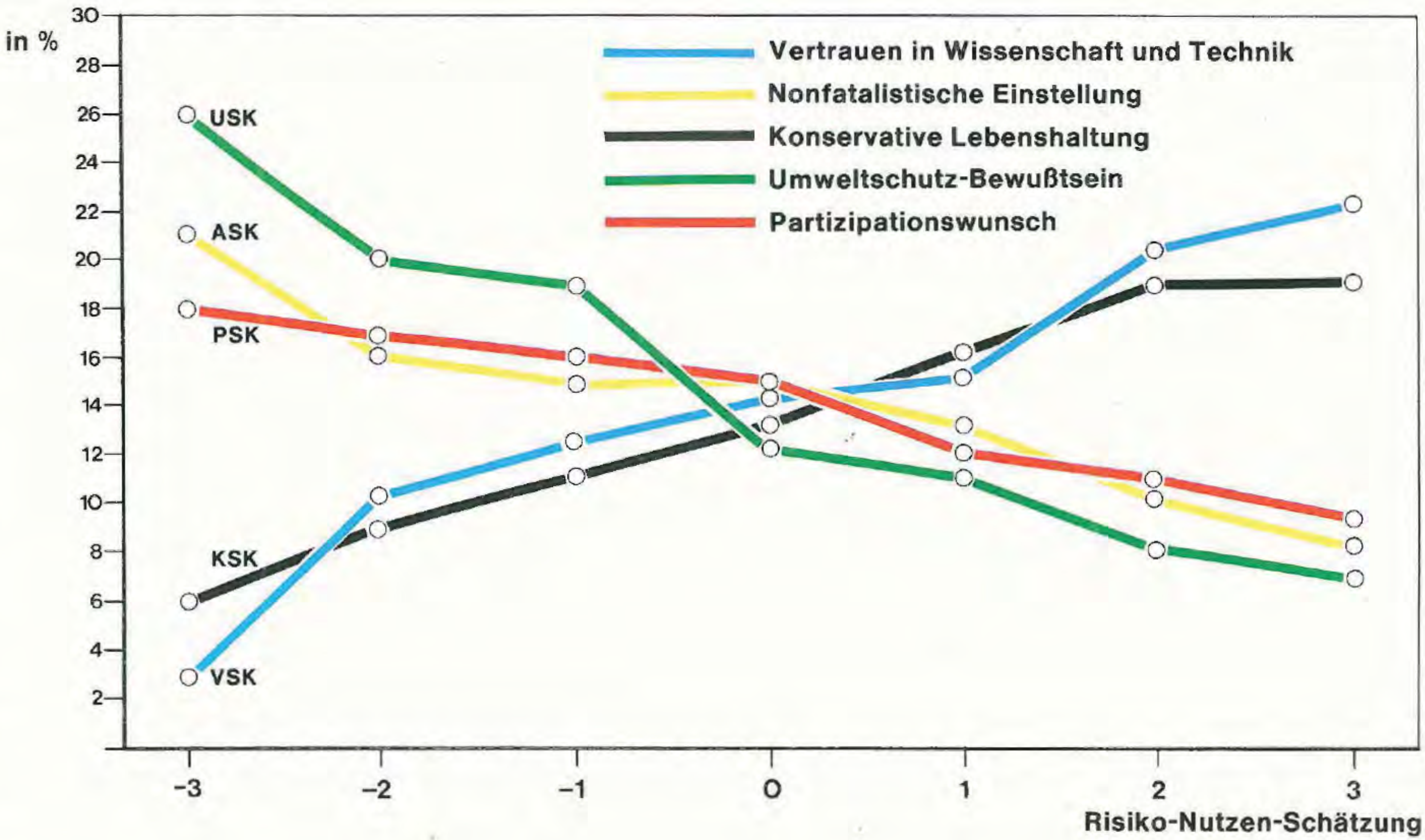


Fig. 31: Effect of Socio-Political Attitudes on the Risk-Benefit Estimation of Nuclear Energy

Conversely, confidence in science and technology and a low degree of environmental awareness represent a starting attitude which tends to develop positive expected values for the nuclear energy attitude. In spite of these convincing results, over 60% of non-explained variance remains. This demonstrates that the deterministic relationship between the socio-political attitude field and nuclear energy attitudes, postulated by Dumenil et al, can hardly match real conditions, although it was impossible to verify all possible, related attitudes within the scope of the present study.

Effect of Social and Demographic Characteristics on Nuclear Energy Attitudes

Relationships which may be revealed in studies of the interrelationship of attitudes and external criteria such as sex, age, class membership etc. do not, at this stage, provide any information on their causal structure. Rather, correlations are indicative of related patterns of the response behaviour which, depending on the significance of the relationship, can no longer be dismissed as random phenomena. This preliminary remark is especially important in the case of the social structural characteristics because, as a rule, they can be interpreted neither as causative factors nor as consequences. In most cases, third factors can be determined (intervening variables) which have an effect on both the social characteristics and the phenomena requiring explanation. Thus, sex in itself is hardly ever the original cause of any behaviour, but the role associated with sex, specific types of education or training, or even stereotype self-perception. Therefore, although the following discussion describes some cross-relations between nuclear energy attitudes and social characteristics in summary form, it should be kept in mind for the interpretation that these are not causative relations but correlations pure and simple.

Nuclear Energy and Sex

Almost all recent nuclear energy polls have revealed as a universal feature that women reject nuclear energy with significantly greater frequency than men. Again using the frequency as the basis of data analysis, a greater rejection rate is revealed in the present study for all the values covered by the survey. This can be seen from Table 32, below.

Table 32: Rejection of Nuclear Energy According to Sex and Residence (in percent)

Sex	All	Kerpen	Jülich	Beverungen	Hamm	Kalkar
Men	52	48	53	49	54	56
pro nuclear energy	51	55	62	53	37	51
undecided	19	10	17	18	24	19
contra nuclear energy	31	35	21	29	38	30
Women	48	52	47	51	46	44
pro nuclear energy	40	47	52	34	22	42
undecided	24	15	24	22	38	21
contra nuclear energy	37	38	24	43	40	37

A glance at the table above shows a special tendency on the part of women to occupy undecided positions. This applies especially to the population of Hamm. In addition, women occupy negative positions with three to five percent greater frequency than positive positions, the only exception being Beverungen where a very great sex-specific deviation (13 percentage points) is noted.

Sex-specific differences are also found in correlation analysis with attitude-forming variables. Women evaluate the nuclear energy risk higher than men and, consequently, also have more negative beliefs. Their attitude structure is less well developed and their behavioural intention slightly lower. This may be due to the fact that they occupy neutral positions more frequently.

An interesting feature is the relationship to the "economic necessity of nuclear energy" variable where there is no difference between men and women and where the correlation coefficient is even slightly negative (- 0.07; not significant). At the same time, women are especially open-minded with respect to alternative energy sources as desirable options for the future. Over 45 % of the female nuclear energy adherents opted for solar energy in the first place, ahead of nuclear energy. The discussion of these results is highly speculative. It is likely that women react with much greater sensitivity to risks which have detrimental effects on health, and are guided more by archetypal beliefs such as the Sun as a life-giving power (Wünschmann, '80, 460). However, the value beliefs and the socio-political attitudes included in the questionnaire revealed almost no significant relationships which would further support this interpretation.

While it is true that a large proportion of women are convinced of the economic necessity of nuclear energy, this aspect apparently has a lesser effect on the evaluation of the different beliefs. Consequently, risks to human life and to the environment have priority over economic objectives. Perhaps men are more receptive to economic necessities due to their direct involvement in the work environment and can therefore compensate risks which they perceive as negative. Women, on the other hand, are more remote from business and, while perceiving economic developments and constraints, subordinate them to their personal environment.

Nuclear Energy Attitudes and Age

The relationship between age and nuclear energy attitudes is less clearly defined than the relationship to sex. A linear trend cannot be identified. A more negative attitude is found in the 25-36 age group, a positive high in the 18-25 age group, average values in the middle age groups and, again, a slightly negative attitude in the group over 56. These data largely match the results of the 1977 study where a preponderance of negative attitudes was found in the 26-35 age group (Renn, '77, 331, p. 109).

It is possible that this distribution is caused by superimposing conventional and modern innovation protest, a phenomenon already discussed in the theoretical part. Traditional individuals of advanced age who are frequently opposed to innovation in their living environment tend to exhibit the same rejection of the use of nuclear energy as the younger generation still affected by the unrest of the sixties, while the very young prefer a positive nuclear energy attitude because they believe in progress and the 35 to 40 age group prefer power stations for reasons of social advancement.

Nuclear Energy Attitudes and Stratification

The class membership characteristic comprises data on income, occupational prestige and educational level. Again, it is of interest to determine the degree to which the social prestige of an individual can be related to his or her nuclear energy attitude. Starting out from the simple correlation values between stratum and attitude-forming variables, it is found that there is a marked effect on nuclear energy knowledge and a lesser effect on the behavioural intention, general belief system and negative bias. The connection between knowledge and class is not suprising, since it is expected that individuals of higher education level and occupational prestige would also have a higher information level. Of greater theoretical interest is the fact that negative nuclear energy attitudes and propensity to take actions increase slightly with higher class membership. This demonstrates that the positive correlation between class membership and nuclear energy attitude which was found years ago can no longer be confirmed. This relationship becomes even more evident when the class variable is subdivided into its basic quantities. Income still exhibits a positive correlation with the nuclear energy attitude ($r = 0.17$), while occupational prestige and education have a negative effect (- 0.19 and - 0.24, respectively). All of these values are significant on the 99 % confidence level. Apparently, therefore, an inversion in the social make-up of nuclear energy opponents and adherents has taken place in recent years, an effect also reported in the United States and Canada. This shift demonstrates an inversion of the innovation protest from a conservative, more ignorant and socially defensive rejection attitude to a progressive, educationally elitist and socially offensive movement. Initially, this change is taking place on a cognitive basis only, while the affective classification lags behind, since the general evaluation failed to reveal any significant differences between the members of the different social classes.

This pattern of class-specific innovation protest can be drawn with still greater clarity if the correlation values of the stratification index are differentiated by attitudes. These data have been compiled in Table 33, below, and plotted in a graph (cf. Fig. 33). With increasing class level the opponents exhibit an overproportional growth in nuclear energy knowledge and behavioural intention. Also, they show a greater firmness (strength) of attitude than the adherents who tend to become more sceptical in their views and risk-benefit

Table 33: Effect of Stratification on Nuclear Energy Attitudes (Subdivided into Nuclear Energy Opponents and Adherents)

Variable	Correlation coefficients Pearson r	Pearson r adherents	Pearson r opponents
Nuclear energy risk estimation	- 0.12	- 0.26	- 0.04
Knowledge	0.27	0.16	0.34
Negative bias	- 0.17	0.03	- 0.16
Belief system	- 0.18	- 0.14	+ 0.13
Nuclear energy evaluation	- 0.08	- 0.02	- 0.11
Nuclear energy safety	- 0.11	- 0.14	- 0.07
Coal evaluation	- 0.17	- 0.15	- 0.18
Solar energy evaluation	+ 0.12	0.14	0.11
Attitude strength	0.06	- 0.05	0.15
Attitude consistency	0.25	0.18	0.28
Action propensity	0.17	0.11	0.26
n	422	187	144

------- p = 0.95 significance

——— p = 0.99 significance

in percent

Knowledge on Nuclear Questions (Opponents of Nuclear Energy)
Knowledge on Nuclear Questions (Proponents of Nuclear Energy)

Willingness to Take Action (Opponents)
Willingness to Take Action (Proponents)

Strength of Attitudinal Commitment (Opponents)
Strength of Attitudinal Commitment (Proponents)

Low Lower Stratum

High Lower Stratum

Low Middle Stratum

High Middle Stratum

High Stratum

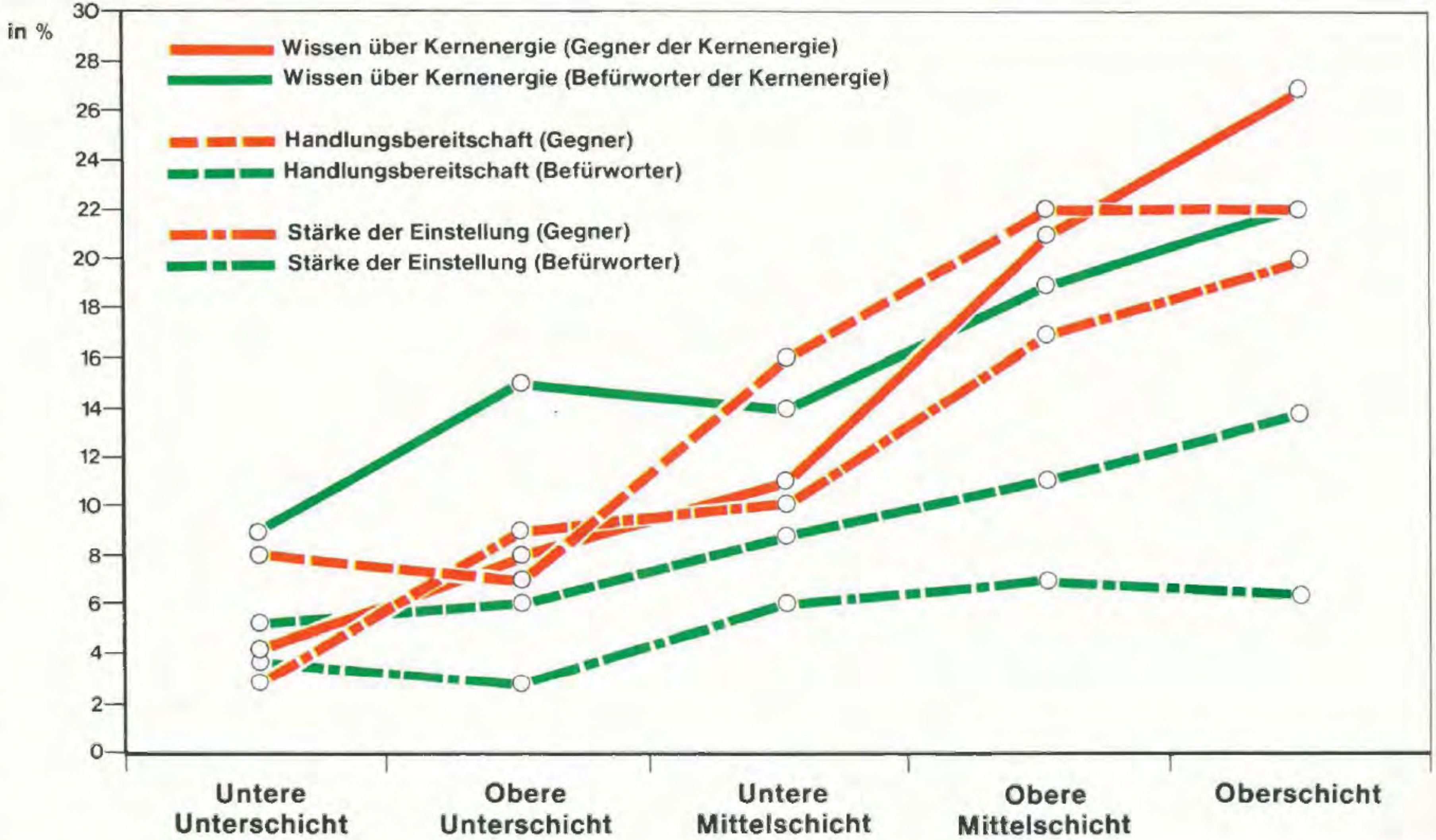


Fig. 32: Attitude-Forming Variables as a Function of Stratum and Position

estimations with higher social position and, accordingly, become less extreme in their attitudes and behavioural intentions.

These results obviously show that opponents tend to reinforce their attitudes with higher social position, becoming still more extreme, still more prepared to take action than they would be on the average, while the adherents tend to become more careful in their statements with higher social position, and are only slightly more prepared to take action. At the same time, opponents in higher social positions exhibit better knowledge on nuclear topics. It is likely that, due to the public discussion and due to the stress caused by the incongruity between their own attitude and their perceived reality, opponents in the upper social positions have concerned themselves more intensively with nuclear energy problems, while the adherents from the upper social strata attempt to overcome their internal incongruity in this respect by suppressing the topic. This assumption cannot be fully verified within the scope of the present study, but the values obtained for the two groups suggest such an interpretation.

It should be noted in passing that interview subjects of all classes were equally interested in environmentalism as a personal or society objective and exhibited relatively similar values on the environmentalism scale ($r = 0.10$; $eta = 0.14$; $sig = 0.05$). This is contradictory to the hypothesis that the relative deprivation of the middle classes is the cause for their commitment to environmentalism. Rather, it appears to become evident that behavioural intention and commitment correlate highly with class membership, causing a greater representation of the middle classes in the organized environmentalist groups. This has also been the result of the present study where, unlike the members of the lower classes, more than double the members of the upper class and upper middle class stated that they gave some kind of support to citizens' initiatives.

Nuclear Energy Attitudes and Political Party Preference

One of the salient characteristics of the nuclear conflict is that it forms a front straight across the institutions of society and the political parties. Just recently, the political success of the environmentalists has initiated a new political polarization which, however, cannot overcome the current leftist-rightist dualism of today's politics but at best expand it by yet another dimension. Both the split across the political parties and the opening of a second front can be seen from the data on voting preferences compiled in Table 34.

The voters of the parties represented in the Bundestag (West German Parliament) are clearly differentiated into opponents, adherents and neutrals. The trend that CDU (Christian Democratic Party) voters have a more positive attitude toward nuclear energy than the voters of the Government coalition parties, has become stronger. This may be due to the fact that the CDU has taken a clear-cut decision in favour of nuclear energy which has been subject to little dispute within the party, and that the affinity of CDU voters to business-related values supports the basic tendency toward attributing positive weight to nuclear energy. This is supported by the high correlation between CDU party preference and business-related objectives (lambda = 0.23; SPD (Social Democratic Party) party preference: lambda = 0.14) and between CDU party preference and the belief in the economic necessity of nuclear energy. On the other hand, the risk-benefit estimation does not differ significantly between SPD and CDU voters.

Table 34: Voting preference as a function of nuclear energy attitude

Voting behaviour in a referendum	Voting preference in national elections SPD	CDU	FDP	DKP	Environmentalists	Others	Undecided	n/%
Pro nuclear energy	47,2	53,3	31,0	50,0	12,2	0.0	38,9	187 44.4
Undecided	14,2	15,8	17.2	0.0	17,1	0.0	27,8	69 16,4
Contra nuclear energy	36,2	27,7	51,7	50,0	65,9	100,0	22,2	150 35,6
Wouldn't go to vote	2.4	3.3	0.0	0.0	4.9	0.0	11,1	15 3,6
n	127	184	29	2	41	2	36	421
%	30,2	43,7	6,9	0,5	9,7	0,5	8,6	100,0

SPD = Social Democratic Party
CDU = Christian Democratic Party (Conservative party)
FDP = Liberal Democratic Party
DKP = Communist Party

The proportion of opponents is unusually high among the FDP (Liberal Democratic Party) voters. However, the possibility of a measuring artefact cannot be discounted in spite of the statistically proven significance of the difference to CDU and SPD voters, since the data base includes only 29 cases.

Surprisingly high is the proportion of environmentalist voters. Since this category included 41 persons, the data base is somewhat broader and yields more information. The frequent nomination of environmentalist groups as the preferred party vote is probably due to desires for consistency (being opposed, one might as well say one votes for the environmentalists) or to demoscopic distortion (environmentalists hardly ever refused to take part in the interviews). Since this study did not concern a voting forecast but relationships between voting preference and attitude-relevant variables, the high frequency of environmentalist voters is even welcome from the analytical point of view.

The median values of a number of variables for the potential voters of an environmentalist party have been compiled in Table 35, below, in order to obtain a better profile of environmentalist voters.

Based on the values in this table, the environmentalist voters are clearly opposed to nuclear energy and in a number of attitude-forming variables take even more extreme positions than the average for the nuclear energy opponents. They exhibit a great environmental awareness and participation propensity and have lost most of their confidence in the experts of science and technology. They are not better informed than the other interview subjects but have less bias on nuclear energy than all the individuals who would vote against nuclear energy

Table 35: Structural data on environmentalist voters (median value comparison)

Median values	Belief scale	Affective evaluation	Nuc. energy safety	Solar energy evaluation	Confidence scale	Conserva-tism scale	Participa-tion scale	Environmen-talism scale	n
Total average	-1.89	3.22	1.26	12.7	5.62	27.9	28.6	16.9	503
Environmen-talist voters	-49.4	-11.4	-8.4	16.8	-3.5	13.1	21.4	30.4	41
T-Test Sig. (99%)	yes	yes	yes	yes	yes	yes	yes	yes	

	Knowledge	Negative bias	Positive bias	Behavioural intention	Strength of attitude	Consistency of attitude	Age	Class	Sex	n
Total average	4.7	1.6	1.1	9.2	5.3	8.5	42	2.6	1.3	503
Environmen-talist voters	5.1	1.8	0.2	17.8	7.4	9.2	31	3.1	1.4	41
T-Test Sig. (99%)	no	no	yes	yes	yes	no	yes	yes	no	

in a referendum. Their nuclear energy attitude is firm, consistent and action-relevant. They are prepared to take far-reaching action above and beyond the average level stated by all opponents. Finally, the environmentalist voters include very many young people and members of upper social strata.

These data have been confirmed by analyses of voting behaviour in the Federal State of Baden-Württemberg where younger voters and persons in the upper social structure more frequently voted for environmentalist parties than older or socially less privileged persons. The interpretation of these data is self-evident: when very negative evaluations of nuclear energy exist and, at the same time, confidence in the technical competence of scientists, engineers and planners has been lost, and when, moreover, there is a high propensity to translate one's attitudes into action, a threshold value is exceeded where the previous party preference is abandoned in favour of a shift to an environmentalist party. This threshold, of course, is lowest where the patterns of voting behaviour have not yet become very fixed, meaning that younger people are probably more inclined to opt for environmentalist parties than older persons who have voted for one of the big parties (possibly different parties at different times) over many years. Since there is a high correlation between behavioural intention and stratification and, at the same time, behavioural intention is one of the prerequisites for changing to an environmentalist party, persons from upper social classes are also found more frequently among the potential voters for environmentalist parties.

Nuclear Energy Attitudes and Other Social Categories

In addition to the indifference of nuclear energy attitudes toward the political spectrum which, however, has been the subject of greater polarization in the meantime - as shown above - almost all studies on this subject have revealed that social category characteristics are independent of nuclear energy attitudes. Neither religious confession, marital status, occupation, nor household size or other variables of this type have been revealed as discriminatory quantities in empirical studies. This lack of influence has been fully confirmed in the present study.

Only education, income and occupational prestige have an effect on nuclear energy attitudes. These, however, have already been taken into consideration jointly through the stratification variable.

Confidence in Institutions and Reference Groups

Man's attitude toward nuclear energy can be based only to a slight extent on his personal experience; rather, information on the nuclear conflict is received via the communication media and processed subjectively. Since most individuals are unable to verify the correctness of this, frequently contradictory, information, the credibility image gains a special weight. It is no longer the information content which is the yardstick for cognitive judgement, but the perceived social situation involved in the information transfer and the estimation of the information source.

Based on the previous results of the analysis of the confidence scale, a marked difference between nuclear energy opponents and adherents would be expected in the attribution of credibility to the institutions of society.

And, indeed, nuclear energy opponents are more sceptical toward most institutions, but not nearly as much as we would have assumed. The numerical data have been compiled in Table 36, below.

This table provides information on a number of circumstances:

- Where credibility in nuclear energy questions is attributed to anyone at all, it is most likely to be the representatives of science and technology or of technically responsible political institutions (such as the Federal Ministry of Research and Technology).

- With respect to assessment of credibility of scientific institutions there are only minor differences between nuclear energy opponents and adherents. Both groups have the greatest confidence in these institutions.

- Central political institutions and technically competent business institutions predominantly occupy intermediate positions on the scale, while general institutions of society such as trade unions and churches, and non-specific social positions such as journalist, manager or local politician, determine the bottom end of the scale.

- Opponents and adherents hardly differ in the basic, tripartite scale attribution: science first, followed by politics in general, and finally the institutions of society. On the whole, however, the opponents assigned lower grades to almost all institutions than the adherents.

- With respect to the credibility of specialized science, opponents and adherents attribute the greatest credibility to universities and nuclear research centres. This is

Table 36: Attributed credibility of institutions in nuclear energy questions

(Medians; range: 1 = high credibility
4 = zero credibility)

Institution	Total median value	Median values Opponents	Adherents	T-Test (p)
Professor at a nuclear research centre	1.44	1.88	1.47	0.00
Scientist at a university	1.72	1.88	1.71	0.03
Reactor safety commission	1.95	2.42	1.80	0.00
Federal Minister of Research and Technology	2.09	2.34	1.99	0.00
Scientist in a citizens' action group	2.32	2.18	2.50	0.00
Representative of the medical profession	2.39	2.42	2.38	0.60
Federal Chancellor	2.40	2.68	2.36	0.00
Spokesman for a citizens' action group	2.60	2.39	2.73	0.00
Chairman of the board of a utility company	2.69	2,91	2.43	0.00
TV commentator	2.70	2.77	2.67	0.18
Spokesman for Social Democratic Party (SPD)	2.95	3.06	2.84	0.01
Spokesman for Christian Democratic Party (CDU)	2.96	3.03	2.86	0.04
Politician	2,99	3,07	2,95	0,09
Spokesman for Liberal Democratic Party (FDP)	3.00	3.00	3.01	0.93
Journalist	3.03	2.97	2.96	0.87
Director of an industrial company	3.10	3.32	2.89	0.00
Local politician	3,12	3,17	3,06	0,15
Trade union leader	3,20	3,24	3,12	0,10
Clergyman	3,56	3.37	3.40	0.64
Chairman of the German Football Association	3,87	3,84	3,68	0,01
Average value Confidence interval	2,71 ±0.23	2,80 ±0.64	2,64 ±0.38	0,01

surprising because the opponents are convinced that the overwhelming majority of the members of these two institutions are in favour of nuclear energy. The competent scientists of the citizens' initiatives are given only third place by the nuclear energy opponents (and eighth place by the adherents). This would not have been expected, considering the homogeneous belief structure of the opponents.

How should these data be interpreted? All the interview subjects agree that statements on nuclear energy by technically competent institutions have the greatest credibility. Political and society institutions are given lesser credibility ratings with decreasing attributed technical competence. The greater the position-bound attitude of scientific institutions, such as citizens' initiatives or the Reactor Safety Commission, the greater becomes their discriminatory effect on positions and attitudes. An almost identical result was found in Goerke's study where the interview subjects predominantly explained the confidence loss of scientific and business institutions by their dependence on fixed institutional objectives (Goerke, '79, 132, p.123). Non-affiliated institutions such as the universities are equally accepted by both sides, although even the nuclear energy opponents believe that most professors would vote in favour of nuclear energy in a referendum. The nuclear research centres range between the affiliated and non-affiliated institutions.

It appears that the nuclear energy adherents require more backing by their confidence group than the opponents who are relatively "generous" in attributing a high degree of credibility even to institutions holding the opposite view, such as the Reactor Safety Commission and the nuclear research centres. It is possible that the opponents can rest more dependably on their consonant attitude structure and, based on this inner certainty, can be more receptive to information which contradicts their personal attitude, while the adherents, uncertain in their inner attitude structure, require strong support by institutions. Economic functionaries, especially private business functionaries, are given the lowest credibility potential by the opponents. It appears that they have lost their stock of potential persuasive power.

Beyond the credibility question, it is of interest to determine the degree to which potential reference groups, i.e. groups of persons whose attitudes and behaviour are emulated by other persons, have an effect on individuals' nuclear energy attitudes. Direct measurement of reference group influence is hardly possible in a sampling survey. Therefore, an indirect procedure was used: all the interview subjects were requested to state how their friends, family members, members of the big political parties, communists, members of citizens' initiatives, university professors and nuclear energy experts would vote in a nuclear energy referendum. In addition, they were asked to predict the probable outcome of the referendum. The results have been summarized in Table 37, below.

This table shows two interesting counter-trends: although most interview subjects would vote for nuclear energy, the majority believes that nuclear energy would be defeated in such a referendum. Among the nuclear energy adherents, approximately one third would not even dare to make a foreca while another third predicted that their own position would be defeated in a referendum. On the other hand, 50 % of the opponents are convinced that their attitude would win in a referendum. However, even in this group one out of four believes that the adherents would win. This first counter-trend has been confirmed by the national polls conducted by the Institut für Demoskopie in Allensbach.

Table 37: Predicted Voting Behaviour (in percent)

Group	Pro nuclear energy	Contra nuclear energy	Difficult to say, still undecided
Subject's own voting behaviour	46	33	20
Predicted outcome of referendum	33	36	30
Predicted voting behaviour of:			
Friends	45	29	26
Family	52	34	14
Communists	11	74	15
Citizens' initiatives, environmentalists	5	92	3
Nuclear experts	92	3	6
University professors	44	19	38
Members of the Christian Democratic Party (CDU)	66	16	18
Members of the Social Democratic Party (SPD)	61	14	25
Members of the Liberal Democratic Party (FDP)	50	22	29

Therefore, since the opponents are much more convinced of the victory of their basic opposing position in a referendum, one would expect this trend to continue in the voting predictions given for the reference groups. On the contrary! Apart from the clearly classifiable groups such as communists, citizens' initiatives or nuclear experts, it appears that the adherents are in the majority among friends and family, professors and members of the three big political parties. The question immediately arises as to why these opponents believe that nuclear energy would fail in a referendum while, at the same time, they classify their primary and secondary reference groups as being pro nuclear energy. In order to study this question in more detail, the predictions given for the voting behaviour of friends and family were differentiated by positions and these values were compared to the subjects' own voting behaviour. Even after this break-down the paradoxical situation remains that nuclear energy opponents are much less certain that their family and friends share their opinions. Among the adherents, 77 % believe that their family, and 62 % that their friends would vote in favour of nuclear energy. Among the opponents, only half are convinced that the members of their primary reference groups are also opponents of nuclear energy. The undecided individuals also feel that more adherents than opponents of nuclear energy are found in their primary environment. The difference between the prediction for the whole (nuclear energy will be defeated in a referendum) and the prediction for the social environment (family and friends would vote in favour of nuclear energy) is remarkable and difficult to explain. Further subdivision of the results by sex and class membership also failed to reveal any better starting point for meaningful interpretation.

It is likely that the frequent reports on nuclear energy protests have so solidified public opinion that unknown individuals are predominantly perceived as opponents, while positive attitudes toward nuclear energy frequently dominate in one's own social environment. It is also possible that, similar to the credibility assessment, the inconsistency of the attitude structure is compensated via an inner dependence on the attitudes of friends and family, thus reducing cognitive stress.

The pattern of reference group effects becomes even more complex when the secondary reference groups, here represented by the political parties, are included. Since the voting preferences of the interview subjects are available, they can be compared to the presumed voting behaviour of party members.

It is found that the nuclear energy opponents also feel that the majority of the members of their preferred political party (with the exception of the environmentalist parties) are clearly pro nuclear energy. In this respect the party for which they vote apparently does not represent their position, and this is clearly perceived. This inter-party separation line between nuclear energy opponents and adherents is even more clearly revealed if the data on the credibility of party spokesmen are included.

Most nuclear energy adherents tend to classify the spokesman for their political party as credible in nuclear energy questions. This applies especially to SPD (Social Democratic Party) voters and to a lesser degree to CDU (Christian Democratic Party) voters, but not to FDP (Liberal Democratic Party) voters. However, this deviation is not significant due to the small data base of FDP voters. Nuclear energy opponents among the CDU voters trust their own party spokesman less than adherents among the CDU voters would trust the spokesman of the competing SPD. This relationship is similar in the case of the SPD.

If one attempts to retain an overall impression from these data, the idea of a shift of political fronts practically suggests itself. The split of the political parties in the nuclear energy question has led to a solidarity movement across party boundaries. Nuclear energy adherents seek support from adherents in all other parties and in this question disregard all the differences existing between the parties. The opponents, on the other hand, feel that they are not properly represented by any political party and, therefore, withdraw credibility in nuclear energy questions even from their own preferred party. The degree to which this new environmentalist front exists for this particular topic only and does not appear with respect to other problems, cannot be determined from the available data. However, there are indications that this third dimension has gained access to the political perception of the population.

Attitude of the Population to Specific Questions of Nuclear Energy Use

In addition to questions on attitude structure and its influencing parameters, some specific problems of nuclear energy use were considered in this sampling survey. These problems, for instance the waste disposal problem caused by nuclear power stations, are also relevant for the overall nuclear energy attitude, but cannot be considered dependent or independent variables; rather, they are supplementary elements in the cognitive image of nuclear energy in the eyes of the population. The evaluation of these interview data yields some interesting information on the span of the perception field, but beyond that aspect has only minor importance for the overall theoretical frame of reference. Therefore, the results shall be reported in summary form only.

Economic Growth and Energy Consumption

Previous analyses had revealed a clear trend toward a positive evaluation of nuclear energy whenever the interview subjects exhibited a more business-related value attitude. This resulted, from the value priorities of opponents and adherents and from the belief in the economic necessity of a further expansion of nuclear energy. Therefore, it was natural to include a specific question on the possibility of eliminating the ties between economic growth and energy consumption, in addition to the general value priorities and economic aspects of nuclear energy. After all, there had been very considerable discussion in the media in 1979 as to whether economic growth processes must, of necessity, be tied to a growth in energy consumption. The answers given by the interview subjects have been compiled in Table 38, below.

Table 38: Elimination of Ties Between Economic Growth and Energy Consumption

Replies in percent	All	Kerpen	Jülich	Beverungen	Hamm	Kalkar
Ties can be eliminated	51	44	50	59	60	46
Ties cannot be eliminated	44	50	48	35	34	51
No opinion	5	6	2	6	7	3

Up to a few years ago, nobody would have doubted a linear relationship between economic growth and the growth of energy consumption. The discussion initiated by scientific publications on this topic has found such a broad response in public opinion within a minimum of time, that over 50 % are convinced today that economic growth can be achieved without increasing energy consumption. Of course, the objection to this will be that the interview subjects were overtaxed with such a question so that the result must be considered as response set. However this is contradicted by the clear-cut phrasing of the question, by the relatively rare use of the "don't know" response and by the similarity of the distribution with respect to related variables. The nuclear energy opponent's position is even more vividly revealed by this result: based on the idea that a reasonable living standard and economic progress can be achieved even without energy growth, he can let himself be induced by his negative risk perception to forgo the use of nuclear energy without having to fear serious disadvantages. This is all the more easy for him because the quantitative values of economic growth mean little to him in any event and because he assigns first priority to the protection of the environment.

Attitude Toward Citizens' Initiatives

Analysis of citizens' initiatives is given great attention in the social sciences literature on protest movements against nuclear energy. Within the scope of the present study this topic was only marginally included in order to compare attitudes toward citizens' initiatives with nuclear energy attitudes.

In addition to the repeatedly cited study by the Battelle Institute which dates back to 1977, two more recent 1979 studies are available which, in conjunction with nuclear energy attitude measurements, were also devoted to the attitude of the population toward citizens' initiatives (Institut für Demoskopie, Allensbach, '79; and Goerke, '79, 132). According to these two sources, most of the interview subjects believed that:

- Citizens' initiatives acted in the interest of the general public and less in the interest of the persons involved;
- Citizens' initiatives did not aim at achieving material advantages for their members;
- Citizens' initiatives were not predominantly influenced by leftist or rightist fractional groups (although this was believed, nonetheless, by about 30 %).

These data are based on representative samples, in one case covering the entire Federal Republic of Germany (Allensbach), and in the other case several towns (Goerke). On the whole, there is a trend over time toward increasing identification of citizens' initiatives with the public interest. However, the dispersion spread has been relatively high since 1975 (cf. Allensbach, '79).

In the present study the interview subjects were presented three statements on citizens' initiatives and requested to select the correct answer. Table 39 provides a review of the statements and percentage values for all survey units.

Table 39: Confirmation of Statements on Citizens' Initiatives (in percent)

Statement	All	Kerpen	Jülich	Beverungen	Hamm	Kalkar
1. Citizens' initiatives represent only their own interests	10	14	5	12	3	13
2. Citizens' initiatives are indications that abuses exist	63	61	73	57	70	54
3. Citizens' initiatives should have participation rights	27	25	22	31	27	33

Citizens' initiatives are attributed a broad functional area especially in those towns where citizens' initiatives contra nuclear energy exist, or have existed in the past, but at the same time they are most frequently attributed self-seeking motives in these towns. In Jülich, Kerpen and Hamm (where a weaker citizens' initiative exists) the "soft" middle course is preferred which states that citizens' initiatives have initiative signalling functions but no decision-making functions. It is apparent that the citizens' initiatives in Kalkar and Beverungen have had a polarizing effect on the population's attitude.

Perception of the Waste Disposal Problem

Based on the analysis up to this point it could be assumed that negative nuclear energy attitudes are accompanied by the belief that radioactive waste disposal is a problem which has not been resolved to this day. In addition, nuclear energy opponents should be much more outspoken against the presently planned waste disposal system than, conversely, the adherents in their positive attitude. In order to test this assumption, three statements on the planned reprocessing facility in Gorleben,Germany, were presented to the interview subjects. The possible responses and the associated frequencies have been summarized in Table 40, below.

It is seen from this table that almost nine out of ten interview subjects felt that the waste disposal problem is not resolved, at least at the present time. Almost 30 % feel that the problem is almost insoluble, while 60 % state that it can be resolved in time. These data already show clearly that even the nuclear energy adherents do not feel that the fuel cycle problem is resolved. Similar results were obtained in Goerke's study in 1978 (cf. Goerke, '79, 132).

One out of two nuclear energy opponents feels that the waste disposal problem is solved in principle, and only one out of twenty feels that the waste disposal technology has been perfected. On the other hand, only 18 % of the adherents believe that the waste disposal problem has been solved. In the overwhelming majority (72 %) they vote for postpone-

Table 40: Confirmation of statements on nuclear waste disposal (in %)

Category	All	Kerpen	Jülich	Beverungen	Hamm	Kalkar	Adherents	Opponents	Undecided
Waste disposal not resolved; no facility in Gorleben	27	30	18	26	29	26	10	52	22
Waste disposal not yet resolved; basically in favour of Gorleben, but more research required	61	65	61	60	64	62	72	43	67
Waste disposal resolved; in favour of Gorleben facility	13	5	21	14	7	12	18	5	11

ment of the construction of a waste disposal facility until, in their view, all the scientific problems have been solved. But they do not consider these problems insoluble in principle. The undecided individuals - as is often the case - range in the middle between the two extreme positions. The perception of the waste disposal problem reveals the position of the nuclear energy adherents. Most of the inconsistency of their belief system is caused by the fact that they believe that nuclear energy is too risky and technologically immature at the present time but they also believe that the problems can be solved in the future and that nuclear facilities are economically necessary. The opponents, however, are not convinced either of the present or of the future necessity of nuclear energy. Like most adherents, the undecided individuals share the opinion that nuclear energy is economically necessary and necessary for our future, but like the opponents they are also convinced that nuclear energy is very risky and that problems such as waste disposal are insoluble (22 %) or at least still unresolved (67 %).

Summary of all Factors Influencing Nuclear Energy Attitudes

Up to this point the analysis included, step for step, new levels of variables and discussed their effects on nuclear energy attitudes. Occasionally the joint effects of the different variables were discussed as well. In the following summary all the external variables shall now be introduced jointly into the evaluation and discussed.

For this purpose the belief scale and the position in a nuclear energy referendum were selected as independent variables, since both of these variables exhibited different causal relationships during path analysis. For statistical reasons, the multiple regression procedure was selected for the analysis of the belief scale, and the discriminance procedure for the position analysis. The results have been summarized in Tables 41 and 42, below.

The state of tension between economic necessity and positions in the nuclear energy referendum on the one hand, and risk estimation and belief system on the other, is again clearly seen from the two tables. In the case of both dependent variables, distorted information - especially positive bias - has a high influence strength. The importance of the attitude consistency variable and behavioural intention variable for the development of a nuclear energy attitude has already been discussed and, once again, demonstrates the difference between nuclear energy opponents and adherents. While a negative nuclear energy attitude is accompanied by a consistent belief structure and a strong behavioural intention, positive attitudes are more frequently accompanied by ambivalent beliefs on nuclear energy and by a more reluctant action propensity.

Table 41: Discriminance analysis of selected factors to explai the voting position in a nuclear energy referendum (ordered according to the degree of declared varianc

Variable	Lambda	Sig.
Economic necessity	0.640000	0.0000
Nuclear energy risk	0.598742	0.0000
Environmental protection scale	0.579827	0.0000
Positive bias	0.563767	0.0000
Sex	0.545869	0.0000
Behavioural intention	0.527820	0.0000
Risk orientation	0.515467	0.0000
Stratification	0.503839	0.0000
Position on media topics	0.493698	0.0000
Conservatism scale	0.487700	0.0
Social justice	0.480983	0.0
Higher income	0.475206	0.0
Age	0.489950	0.0
Solar energy attitude	0.465685	0.0
Unemployment	0.462438	0.0
Value: Environmental protection	0.458296	0.0
Negative bias	0.455283	0.0
Preference for personal health	0.452003	0.0
Standard of living	0.449071	0.0
Strength of attitude	0.445452	0.0
European unity as political aim	0.442426	0.0
Confidence scale	0.4390013	0.0
Benefit orientation	0.436095	0.0
Political radicalism	0.438698	0.0

Table 42: Regression analysis of selected factors to explain the nuclear energy belief system

Variable	Multiple R correlation	R squared declared variance	R squared change	Significance
Nuclear energy risk estimation	0.71283	0.50812	0.50812	0.00
Positive bias	0.87492	0.76548	0.25736	0.00
Negative bias	0.89959	0.80927	0.04379	0.00
Consistency of attitude	0.91262	0.83288	0.02361	0.00
Confidence scale	0.91916	0.84485	0.01197	0.00
Positive associations	0.92392	0.85363	0.00878	0.00
Nuclear energy budget	0.92634	0.85810	0.00448	0.01
Preference for high income	0.92875	0.86257	0.00447	0.01
Economic necessity of nuclear energy	0.93042	0.86569	0.00312	0.04
Behavioural intention	0.93167	0.86800	0.00232	0.03
Environmental protection scale	0.93251	0.86957	0.00157	0.01
Sex	0.93318	0.87082	0.00124	0.16
Nuclear energy as a major political problem	0.93413	0.87260	0.00179	0.07
Environmental protection as a value	0.93463	0.87354	0.00093	0.13
Knowledge about nuclear energy	0.93511	0.87443	0.00090	0.03
Risk orientation	0.93554	0.87524	0.00080	0.01
Participation scale	0.93585	0.87582	0.00058	0.00
Benefit orientation	0.93611	0.87630	0.00049	0.00

The socio-political attitude and value preferences included in the questionnaire are also important factors for both dependent variables. While the environmentalism attitude and the two value beliefs of social justice and high income (as counter-poles) have the greatest effect on the position taken in a referendum, confidence in science and technology in general and the high income and environmental protection values play an important role in the case of the belief scale. However, the correlation coefficients indicate that accompanying attitude and value beliefs cannot be considered determinant variables (as postulated by Dumenil).

The two dispositive characteristics of risk orientation and benefit orientation are included in both influence patterns and, consequently, support the results of the comprehensive survey on the perception patterns of risks. Other external variables include sex, represented in the belief system, and sex, age and class, represented in the position. The strength of influence remains within limits, however. Yet it is interesting to note that attitude-forming components are less dependent on social structural characteristics than the position differentiation.

In evaluating the information content of these two influence models it must be kept in mind that both internal and external dependencies have been represented. Consequently, the squared R-value of multiple regression does not as yet imply that 88 % of the variance of the belief system could be explained by external variables. Therefore, another regression was used to exclude all internal variables such as nuclear energy risk estimation, bias etc. This yielded a multiple R^2-value of 0.64. This value is still high enough to prove conclusively the influence of external factors. Elimination of the internal variable changes little in the sequence of the variables included; only the risk orientation, a dispositive characteristic, moves up to second place behind the confidence scale.

The same applies to position differentiation. Together with the internal variables, almost 76 % of the cases can be correctly attributed. When all the internal variables are eliminated from the analysis, this value drops to 62 %. This, too, can be interpreted as a good prediction value for the independent variables.

General Conclusion

Since the beginnings of our history, technology and man have been in a state of tension: man has learned to make use of instruments to refine and perfect his non-specialized organic nature in any desired direction. Technology helps him to move faster than any animal, to see, hear and smell better, to obtain food faster and in greater quantities, protect himself more effectively against hazards and natural risks, prolong his life span to the biological limits and ensure an intensive propagation of his species. However, a price must be paid for this progress: increasing specialization and differentiation in society result in anonymous and incomprehensible social structures which the individual can no longer understand; technological systems of ever greater perfection and cost increase the risk of being killed by the machine which man himself has created. The acceleration of production efforts create more and more environmental pollution which, in the final analysis, can destroy the foundations that support human life. Last but not least, technology can also amplify the negative developments in human society: the more efficient our technology, the greater is the potential scope of catastrophic events when aggression takes place, be it in the form of crime, terrorism, civil unrest or war.

There is no doubt that the ambivalence of technology exists. Many types of societies have deliberately forgone any forced advancement of technological progress because the social dynamics associated with the development of new instruments would have threatened the static conditions in these societies. Therefore, in the 19th Century, technological progress meant overcoming rigid hierarchies and post-feudal power conditions. Until the past decade, the advancement of science and technology was considered a priority task of society, associated with high positive value and a progressive image. However, within a short period of time the problems caused by major industrial facilities, an increasing awareness of the environment, disillusionment as to the limitations of research and technology in important areas (such as cancer research), employment problems due to automation, and saturation phenomena in the consumer area have initiated a reinterpretation process which has pointed the spotlight of perception at the ambivalence of technology. Last but not least, the concepts for soft or alternative "counter-technologies" have stimulated the increasingly critical discussion on technology and its consequences.

In this situation, where cognitive contradictions and a successive change of value beliefs and ethics both introduce uncertainty into man's belief system, studies on the perception of technology achieve their special significance. The task consisted of using the tools of empirical social research to trace the risk perception process and show how attitudes are formed. This, of course, was not possible for technology as a whole. Rather, an especially controversial topic, use of nuclear energy, was selected as an example for the selective study of the determinants of risk perception.

How can we reconstruct the risk perception process on the basis of the empirical results? Are there any universal patterns for processing risk-related information?

Using the basic risk perception and acceptance model described in Part II of this book, the perception process can be subdivided into the following steps:

- Information reception;
- Development of cognitive beliefs;

- Weighting of these beliefs by attributing probabilities;
- Evaluation of these beliefs on the basis of attributive and qualitative, dispositive and situative factors;
- Internal clarification of beliefs (development of a consistent attitude);
- Acceptance decision;
- Rationalization of this decision.

Now the results of the present study can be allocated one by one to these steps, shedding a little light into the "black box" of perception and acceptance.

1. Information Reception

Beliefs on complex technological risk sources are formed predominantly via information received from third parties. The less our competence to verify the correctness of a statement, the more we are dependent on the subsidiary aspects of information which result from the interactive situation. In the case of nuclear energy it was shown that the adherents attribute special credibility to those information sources which on the basis of their personal image are considered pro nuclear energy experts. The opponents, on the other hand, consider even those experts credible and reliable whom they perceive to be adherents, but they have lost all confidence in functionaries representing business interests.

In a similar pattern, nuclear energy adherents perceive in their direct and indirect social environment a much greater proportion of pro nuclear energy attitudes than the opponents perceive contra attitudes. These findings apply only to identifiable reference groups. When it concerns quite generally the perceived public opinion, most of the interview subjects believe that a negative attitude toward nuclear energy is predominant in the Federal Republic of Germany. The desire to find strong backing by attitude-reinforcing experts, and the support sought by perceiving like-minded persons in the social environment and in the institutions of society, are more characteristic for nuclear energy adherents than for opponents. It was attempted to explain this fact with the theory that the adherents are dependent on social support for their attitudes in order to compensate their inconsistent beliefs (more dissonant elements), while the opponents, due to their more homogeneous attitude structure, require less social support.

If these findings on nuclear energy attitudes could be transferred to other risk sources, the result would be an interesting compensation mechanism to overcome cognitive dissonance: the problems involved in forming one's own judgement are reduced by a subconscious delegation of decision-making powers to social authorities and by seeking protection within a perimeter of identical attitudes. The greater the homogeneity of attitudes, the less will be the necessity of this type of social re-insurance.

2. Development of Beliefs

After absorbing the information and weighting the information source, the next step is to integrate the information into the belief system. The results of this study suggest the conclusion that the perception of risk sources does not take place in accordance with a uniform reception pattern but that each source is associated with object-specific characteristics. However, in the case of all risk sources covered by this study a tendency was revealed to separate the perceived information into the categories of "personal involvement" and "economic and society-related aspects". Within these major blocks, specific patterns developed. The benefit-risk relation was always positive when personal advantages were subjectively perceived without any doubt.

Conversely, perceived personal disadvantages result in a negative attitude. In the case of risk sources given an ambivalent evaluation, such as nuclear energy or pesticides, the general society-related, economic and technological problems occupy most of the attention, while the personally perceived advantages and disadvantages are approximately balanced.

The degree of knowledge about a risk source does not have any effect on the general attitude, at least in the case of nuclear energy. However, this does not apply to the self-evaluation of the interview subjects' information level: here the adherents prove to be especially self-confident, while the opponents give themselves a more sceptical evaluation. Also, the adherents believe that other citizens are much less informed than they are, while the opponents, again, do not see any differences in the information level between themselves and others.

3. Attribution of Probabilities

Probabilities are absorbed together with the information, but are allocated intuitively. Within the scope of the present study it has not been possible to confirm the assumption that the size of a possible catastrophe is always given a greater weight than the probability of its occurrence. At least within the range of the comprehensible numerical relationships, the interview subjects attributed similar weights to both parts of the scientific risk equation. However, the abstract numerical relations appear to have only a small influence on the imagination of individuals, since excessive risk dimensions are considered possible in the case of risks frequently discussed in the media where the catastrophes can be directly imagined. Thus, most interview subjects believed that they would live to see one reactor accident which would cause 600,000 deaths (median value). Even the most pessimistic risk calculations would show up this value as being in the realm of fantasy. Other, easily imaginable hazards (such as being caught in an avalanche while skiing) are also overestimated in terms of time and dimensions of a catastrophe. It is seen clearly that the interview subjects can state fairly reliable averages for hazards per annum, but are not able to predict the probability and the dimensions of extreme accidents. In this respect it doesn't matter whether the risk dimensions or the time frame are given as constants. The last result to be mentioned is that the failure probabilities of redundant safety devices, such as double barriers, are not multiplied but quite obviously summated.

4. Evaluation of Beliefs

Evaliation of beliefs by their personal importance is the most important step in risk acceptance and, therefore, the major area of interest for the present study. The relationship to the subject (what have I got to do with it?), the potential exposure (will I have to bear the risk?) and qualitative characteristics (which positive or negative side effects can be expected?) were emphasized as internal evaluation patterns. In the case of the qualitative risk characteristics (such as voluntariness, personal control), a verifiable effect on the acceptance of the risk source was found only when certain orders of magnitude of these characteristics were exceeded. Thus, voluntary risk acceptance and the possibility of individualizing the harmful consequences increase the propensity to tolerate risks, while the possibility of long-term harmful effects and severe localized consequences lead to a negative evaluation of the risk source in question It was clearly demonstrated in both experiments that risk sources are more easily accepted when they are accepted voluntarily or associated with a possibility of personal control. However, tha assumption was disproved that the qualitative risk characteristics have a determinant effect on the risk-benefit estimation. They are one factor among many.

The question as to the distributive effect of risks was not verified explicitly. However, the study of qualitative characteristics of the analysis of the experiments revealed a clear tendency that risk sources with equally distributed benefit and detriment are more easily accepted than risk sources with imbalanced benefit and risk distribution.

Among the subject-referred characteristics the following quantities were included: risk and benefit orientation, general value beliefs, socio-political attitudes as well as demographic and social structural characteristics. General risk and benefit orientation has a surprisingly high effect. Measured in terms of the consistency of high or low risk evaluations, this variable correlates strongly with the independently measured risk source evaluation and with the question as to the desired procedure for handling the risk (from support to prohibition). This relationship was identified in all three surveys and for most risk sources. Additional studies will be required to determine whether this allows the conclusion that a phenomenon such as a dispositive tendency toward risk overevaluation or underevaluation exists.

Both, the general value system and the socio-political attitudes are important influencing quantities which have an effect on the estimation of the nuclear energy risk source. The same applies to the evaluation of the chemical plant as a risk source which also depends on the value system and attitude environment scales included in the questionnaire, while the risk sources of coal energy, solar energy and other alternative energy sources are largely independent of these two classes of variables and are given homogeneous evaluations by all the interview subjects. This suggests that risk sources which have political and society-related aspects, such as nuclear energy, pesticides and chemical industries, are also affected by the socio-political attitude environment, while considerations of expedience and enjoyment predominate in the case of risk sources which are mostly perceived as technological or personal risk sources (coal, smoking). Society-related values and attitudes play a minor role.

Among the social and demographic characteristics,stratification and sex are of special interest. With higher class membership the importance of personal aspects of risk perception declines and they are replaced by socio-political arguments. Consequently, it is not surprising that, following the discussion on the disadvantages to society caused by nuclear energy, negative attitudes toward this energy source increase with higher class mambership. This relationship is also remarkable from a theoretical point of view because diffusion research has in most cases associated opposition to innovation with traditional value attitudes, conservative ideology or lower class situation. It is seen, therefore, that an inversion has taken place over time.

Women react with special sensitivity to health risks and are less receptive to business-related values and objectives. In the nuclear energy question these two effects intensify each other. The perception of the health risk can be compensated only inadequately by the perception of the economic necessity of nuclear energy because these values are of lesser importance in the belief system of women. The same effect is found in the case of pesticides and food preservation.

Age has only a minor effect on risk perception, and different patterns of influence are found from one risk source to another. In the case of nuclear energy evaluation it is especially the youngest people (16-25) and the middle-aged (from 46 up) who tend to have a more positive attitude toward nuclear energy, while the age group from 26 to 35 has the most negative attitude. This relationship has been identified exclusively for nuclear energy and not for any other risk source.

On the whole, therefore, it is found that almost all the belief evaluation factors discussed in theory have an effect. In terms of total effectiveness the subject related characteristics predominate, but for these only a few typical patterns were identified. Qualitative characteristics are more easily systematized, but are decisive for risk perception only when certain threshold values in their development are exceeded. Dispositive and situative characteristics are also relevant influencing quantities which, however, require differentiated analysis for each risk source.

5. Development of a Consistent Attitude

In the conceptional model of risk acceptance the weighted beliefs which are relevant for a decision are classified, and contradictory elements are eliminated. This process step cannot be recreated in an interview. In the case of nuclear energy attitudes we noted a relatively well-reinforced and homogeneous attitude structure on the part of the opponents, and a more ambivalent system with many dissonant elements on the part of the adherents. It is possible that the subjective impression that most of the direct social environment has a positive attitude toward nuclear energy has required a greater elimination of dissonant elements on the part of the opponents. Following this attitude reinforcement, however, the opponents have become more open-minded toward the arguments of the experts, even though, on the whole, they have less confidence in the statements of scientists and engineers (even those who belong to their own camp).

6. Acceptance Decision

The acceptance decision was defined as striking a balance after risk weighing, directly measured as a risk-benefit estimation and, indirectly (and applicable to nuclear energy exclusively), determined via the voting behaviour in a hypothetical referendum on the further expansion of nuclear energy. The risk-benefit estimation is subject to almost the same relationships as the sum total of the belief system. Both quantities correlate strongly (0.71). A simulated referendum on nuclear energy revealed the influence of business- and society-related valuations even more clearly than in the case of risk evaluation. Those who are convinced of the economic necessity of nuclear energy will usually vote for this energy option even though they feel otherwise that nuclear energy involves more detriments than benefits. Therefore, acceptance decisions are more affected by the political power play (energy crisis, accidents) than attitudes.

7. Rationalization

The degree to which, after developing an attitude, elements of the belief system are modified in order to achieve a consistent overall pattern, is also difficult to determine through empirical research. However, a number of indirect observations seem to indicate that individuals did indeed rationalize their own position. Thus, a considerably greater number of interview subjects stated that they would vote for environmentalist parties than was actually the case. A highly plausible explanation for this phenomenon is that committed nuclear energy opponents wanted to lend adequate weight to the decisiveness of their attitude. Even in the case of very topical subjects such as eliminating the ties between economic growth and energy consumption, and the nuclear waste disposal problem in Gorleben, at least the opponents exhibited an extremely attitude-related response behaviour.

8. Risk Perception and Social Research

The sequence of steps involved in the risk acceptance process, outlined only briefly in this chapter, provides just an impression of the variety and complexity of risk perception among the population. Many mechanisms of intuitive evaluation can be revealed by empirical means and compared to model concepts. The result has been that the presently existing concepts on the processes involved in risk perception are too narrow. Although it has not been possible to clarify fully the overall risk perception process, the results achieved in this study seem to allow the hope that this better insight into the structure of risk perception could contribute to an understanding of the structure of opinions and positions held by the public and, consequently, toward overcoming unnecessary communication barriers.

It is not the ambivalence of technology which was under discussion here, but its perception. It is immaterial whether it is justified, objectively true, rational or irrational. Such a comparison inevitably leads to the development of elitist theories where, based on a false antagonism, the "naive" attitude of the population would be discredited in comparison to the experts' judgements. This is not in keeping with either the purpose or the meaning of psychological studies on risk perception problems. In particular, the results of this study have shown that the spectrum of factors involved in an acceptance decision is much more complex and varied in the perception process of the population than it is in the scientific and technological approach with whose results the public is quite familiar. If studies of this type fulfill their purpose of pointing out the relevant factors of risk perception, the concerns of the population and the cognitive problems involved in the evaluation and handling of technology, then the effort expended on this research has already been worthwhile . For , in the future it will be more important than ever that we can find our way back to a strategy which will find a consensus of opinion when grave technological decisions must be made.

Appendix

Index of Technical Terminology with Definitions

Acceptance
Positive judgement about an object or a procedure

Acceptance Threshold
Internal limit above which objects become acceptable to an individual or group

Aggregate Evaluation
cf. Evaluation

Allensbach, Institut für Demoskopie
National Opinion Poll Establishment

Alienation
Category describing the discrepancy between a man's work and the resulting product in modern manufacturing

Anxieties
Diffuse fears of threat
- Suppressed anxieties
Emotions which are not admitted as being felt
- Anxiety-Envy syndrome
Theory developed by Röglin according to which modern societies are characterized by a combination of anxiety and envy as a psychological channeling of lack of orientation

Archetype
Typical subconscious orientation patterns with high affective tension (acc. to Jung's theory); cf. pp 22/23

Attitude
See definition on Page 87
- Attitude components
In our opinion, attitudes consist of three components; cognitive beliefs, affective evaluation and behavioural intention

Attributes
Allocation of properties to certain objects
- Attributive biases
Intuitive incorrect allocation of properties to objects or of incorrect conclusions on the basis of information received
- Attributive theory
Systematic assessment of intuitive attribution processes

Availability
Form of attributive bias where events are assessed as being more probable, the better they can be remembered

Belief
Idea as to the characteristic properties of an object or a person
- Belief system
Sum of all organized ideas with respect to an object
- Salient beliefs
The decisive ideas for the attitude taken toward an object
- Weighted beliefs
The ideas held with respect to an object multiplied by the affective significance of the content of the idea

Bolstering
Removal of self-doubt as to the correctness of a decision once it has been made

Capitalistic Production Crisis
cf. Crisis

Citizens' Action Group (Initiatives)
Short-term organization of citizens affected, with the aim of preventing, modifying or initiating projects in their immediate environment.
In the Federal Republic of Germany, umbrella groups covering larger areas have developed from several of these local groups, particularly in the environmental protection movement

Citizen's Initiatives
cf. Citizens' Action Group

Cognitive
Characteristic of the information content of beliefs.
- Cognitive component
One of the three components of the attitude structure
- Cognitive dissonance
Contradictory information content with respect to a single object. It is assumed that everyone attempts to remove dissonances
- Cognitive stress
Psychological tension caused in the perception process by contradictory information content or by attitude-destroying information

Collective Subconscious
Unconscious, internalized attitude pattern within a societal group

Common Mode Failures
Several errors in a technological system occurring simultaneously

Common Sense Processing
Intuitive processing of external stimuli or information

Communicative Consistency
Parallel nature of communication content (cf. p. 42)

Compensation
Economic: Compensatory payment
Psychological: Overcoming psychological deficits or setbacks by means of performance in other areas

Compensation Payments
Transfer payments as compensation for damage suffered

Components of Risk
cf. Risk

Conflict Theory
Sociological theory, according to which the basic features of social development are determined by the conflicts occurring between the "actors" in a society and the resulting conflict resolution strategies

Consistency of Attitudes
Congruence between the cognitive and affective elements of an attitude structure (cf. Attitude)

Correlation (Coefficients)
Measure of the strength of a linear connection between two variables. A correlation coefficient of 0 means that there is no connection, a coefficient of 1 means total agreement.
- Multiple correlation coefficient
Connection between one dependent and several independent variables
- Squared correlation coefficient (r^2)
The square of the correlation coefficient r gives the proportion in per cent of the declared variance for the dependent variable
- Types of correlation coefficent
In statistics there is a large number of correlation coefficients, the use of which depends on the measuring level of the variables (nominal, ordinal, at graduated intervals or rational) In this work, the following coefficients are used:
Pearson r, Lambda, Gamma, Eta, Spearman, Tau, Phi; the formulas for calculating these coefficients can be found in any statistics textbook.

Cost-Effectiveness Method
Economic method of optimizing the efficiency of expenses for projects

Crises
Subjective impression of a malfunction in a continuous mental or action-related development, where the final objective no longer seems attainable
- Capitalistic production crisis
According to Marxist theory, the imminent collapse of the capitalist economic system which is inevitable because of the antagonism between profit interest (maximalization of greater value) and worker interests
- Identity crisis
Disturbance in the individual maturing process of acquiring a self-identity, usually as a result of lack of orientation and insecurity of values
- Legitimacy crisis
Impression that the official national powers are no longer in a position to handle the problems of the future
- Value reflection crisis
Lack of orientation with respect to the validity and logic of rival value beliefs

Decision Analysis
Field of science concerned with form, types and processes of decision-making
- Descriptive decision analysis
Descriptive analysis of the actual decision-making process by individuals or institutions
- Normative decision analysis
Compilation of processes in order to be able to make decisions as rationally as possible
- Typological decision analysis
Compilation of typical decision-making process patterns
- Explicative decision analysis
Compilation of the logical and mathematical bases for decision-making processes

Descriptive Decision Analysis
cf. Decision Analysis

Displacement
Psychoanalytical term: unpleasant memories or beliefs are forced down from the conscious mind into the subconscious

Diffusion Research
Branch of sociological research concerned with the introduction and dispersion of innovations in a society

Divisibility
See Page 41

Distributive Equivalence
Equal distribution of benefits and risks over the population (cf. p. 419)

Dispositions
Properties inborn or acquired in the human psyche

Dummy Variables
Nominal variable (e.g. religion) which can be converted into metric variables (data at graduated intervals) by splitting it into several "yes-no" variables (Catholic yes-no, Protestant yes-no) so that it can be more easily evaluated statistically

Discriminance Analysis
Statistical method of determining the connection between one dependent and several independent variables, not at graduated intervals, only the joint effect of all independent variables being taken into consideration

Ego-Stabilizing Orientation
Establishment of a value system which justifies and safeguards the individual personality and action

Elimination by Aspects
Method of decision-making for multi-dimensional problems (see Page 14)

Environmental Assimilation
The perception and processing of environment-related information and experiences

Environmentalist Movement
Organized but not yet officially channelled influence control movement to bring about changes to improve the environment by means of mass mobilization

Error Tree Analysis (Fault Tree Analysis)
Statistical method to determine synthetically the probability of failure of a system in the case of rare occurrences using the combination of failure probabilities of the individual system components

Eta cf. Correlation

Evaluations
Affective evaluations (weights) of beliefs with respect to an object or an individual
- Evaluation scale
Measuring process for obtaining the affective weighting of beliefs
- Aggregate evaluation
The unification of affective weightings for several objects

Expected Values
The losses or gains calculable per unit of time using the probability function

Explicative Decision Analysis
cf. Decision Analysis

Exploratory Research
Research which attempts to probe the scope and depth of phenomena to be explained, without as yet using a strict methodical concept

Falsifiability

Term from the scientific theory of critical rationalism (Popper). Working from the realization that there is no real possibility of proving the truth of a statement,statements made on the basis of scientific conventions are considered as being only provisionally proven until they can be proven false. For this purpose, however, it is necessary to be able to subject the statement to thorough empirical examination

Fishbein Model

Attitude concept according to Fishbein, where beliefs about an object are multiplied by the affective weightings of the content of the belief (beliefs x evaluations)

Functionalistic Approach in Sociology

The sociological school of thought which classifies actions and institutions within a society according to their degree of functionalism or dysfunctionalism for the smooth running or maintenance of basic social structures is described as functionalistic or structurally functionalistic.

Functional Determinacy

Direct and perceivable relation between the benefits of an object and the person receiving the benefits (see Page 42)

Factor Analysis

Statistical method of tracing back a number of variables to the major basic factors and of acquiring the dimensions of the multiplicity of variables

- Factor loadings
  The strength of the influence of each variable on the factor representing it
- Factor score coefficients
  The weight of each individual variable in the summation to a factor
- Three-dimensional factor analysis
  Factor analysis as a function of a third variable (e.g. sex, age, etc.)

Gamma

cf. Correlation

Game Theory

Part of decision-making theory where the reactions of the "game participants" affected by the decisions made are incorporated into the calculations

Hierarchic Needs Structure

According to Maslow's theory, there is a hierarchy of needs in which attempts are only made to satisfy a higher-level need when the one immediately below it has been satisfied. The 5 stages are as follows: physical needs, safety, affection, self-esteem and self-actualization

IAEA International Atomic Energy Agency in Vienna

Identification
Process for the internalization of ideas or beliefs as part of the individual's own self-value concept

Identity Crisis
cf. Crisis

IIASA
International Institute of Applied Systems Analysis in Laxenburg, Austria

Inadequate Reciprocation
Imbalance between two dependent systems (one gives more than it receives). An inadequate reciprocation requires a transfer legitimation (e.g. ideology, altruism, power) in order to become stable

Institut für Demoskopie, Allensbach
cf. Allensbach

Intentional Value Congruence
Congruence between changes in society caused by innovations and the existing value system (see Page 41)

Internalization
Internalization of values and norms

Internalized Risk Threshold
Individually established threshold above which risks are considered to be unacceptably high

Intervening Variables
Variables forming part of a causal chain between the causative and the dependent variables

Intuitive Generalization
Types of process prevalent among the general public for drawing conclusions from specific data and applying them to general circumstances (see Page 71)

Intuitive Regression
Attributive bias when intuitive conclusions are drawn, where statistical exceptions are assessed as criteria for the probability of future behaviour

Invaccination Effect
Attitudes which have been exposed to low-level loads over a long period of time, still remain stable if more extreme forms of attitude-destroying experiences are undergone

Lambda
cf. Correlation

Latin Square
Specific arrangements of test groups in experiments in order to assess separately the influence of several stimuli

Legitimacy
Confidence in the problem-solving cognition of political decision-makers

Legitimacy Crisis
cf. Crisis

Marginal Utility Theory
Economic theory according to which the value of a product is measured against the subjective benefits of the last used unit

Materialized Rule
Power relationships are disguised by means of the interpolation of non-power-related authorities or objects (e.g. time clocks)

Mixed Scanning
Theoretical decision-making process where the selection from a series of optimal or sub-optimal solutions is left entirely to the social and political powers (see Page 15)

Muddling Through
Decisions are made according to the free interplay of the political powers and spheres of influence (see Page 15)

Multiple Correlation Coefficient
cf. Correlation and Multiple Regression

Multiattributive Utility Measurement
Process for calculating the overall utility of projects or products which cause benefits and damage in more than one dimension

Multiple Regression
Statistical process for estimating the joint influence of a large number of variables on a single dependent variable. The multiple regression presupposes data sets which are graduated at intervals and which have a normal distribution curve
- Multiple correlation
  cf. Correlation
- Squared multiple correlation
  Declared variance of the dependent variable

New Economic Theory (Economics of Politics)
Transfer of economic terms and process analyses to the explanation of the political behaviour of institutions and members of the public, for example considering voting to be a market decision for political programmes

Normative Decision Analysis
cf. Decision Analysis

Normative Democratic Structure
Belief system with respect to the way a society oriented to democratic ideals ought to be organized

Opinion Leaders
People whose opinions carry a large amount of weight in their local surroundings and who have an opinion-forming influence on the individuals in their environment

Overt Anxiety
Externally observable behaviour which suggests anxiety feelings

Participation (participatory)
Participation in political decision-making processes (ranging from participation in the passing of a resolution to co-determination)

Pearson r
cf. Correlation

Perception
Mental representation of images about objects or persons
- Associative perception
  see Page 61
- Communicative perception
  see Page 60
- Intuitive perception
  see Page 61
- Self-perception
  Self-image of own personality

Phi cf. Correlation

Political Apathy
Resignation to or disinterest in political issues

Political Economy
cf. New Economic Theory

Political Exchange System
cf. Social Exchange System

Portfolio Theory
Mathematical and axiomatic variant of the descriptive decision-making theory (see Page 11)

Pragmatic Political Approach
Analyses as to how political deficits may be balanced out by new forms of political decision-making without involving changes in the overall system

Probability
see Pages 57/58

Projection
- Economic term: perceived advantages of a project which will take place in the future
- Psychological term: transfer of personal mistakes, which one does not want to recognize, to other people or objects
- According to Röglin (see Page 25): the problem-solving capacity of a functional object

Psychological Inconsistencies
Contradictory perception patterns and processing categories in the psychological handling of external stimuli

Psycho-Affective Reinforcement
Intensification of beliefs and opinions which most closely correspond to internalized values and feelings

Qualitative Risk Characteristics
cf. Risk

Quota Sampling
Selection procedure for random sampling, where the respondents are selected according to particular features (e.g. age, sex, income) from representative or systematic viewpoints

r or r^2
cf. Correlation Coefficient

Reality Stress
Tension arising when the perceived development of a society does not agree with the wishful thinking as to how this development ought to appear

Rationalization
Phase following attitude formation when decisions once made are safeguarded in retrospect with arguments

Reduction of Complexity
The most urgent task of political and social systems, according to the political Systems Theory, is to simplify complex problems and to find solutions which are acceptable to all.

Reduction of Technological Complexity via Moralization
Premise made by E. Scheuch, according to which environmental structures which have grown too complex to be understood by common sense or formal education can be cognitively handled by means of applying moralization processes to the relevant problem

Reference Group
Group within society to which one would most like to belong

Referred or Expressed Preference Analysis
Method in descriptive decision-making theory of determining preferences for solutions via surveys

Reinforcement
Reinforcement of behaviour or thought patterns by internal or external stimuli (term from theory of learning)

Relative Deprivation
Deprivation of people or groups of people in particular areas, although in other areas equality or even privileges exist

Representativeness
Attributive bias according to which redundant information and pre-structured beliefs suggest a belief in the representative nature of this information or these beliefs for everyone

Revealed Preference Analysis
Method in descriptive and normative decision-making theories where the acceptability of risks is derived from the previous scope of acceptance of familiar risks

Role Attribution in Interactive Situations
Allocation of expectations to people with whom one is communicating

Risk
Definition: see Page
- Risk acceptance: see Page
- Risk assessment
The systematic assessment and weighing up of all possible positive and negative consequences of a risk source
- Risk dimensions: see Pages
- Risk Estimation
The intuitive assessment of risk consequences
- Risk evaluation
Assessment of identified risk consequences
- Risk identification
Assessment of risk consequences without analysis of their probability and without weighing up or evaluating the damage
- Risk perception: see Page
- Risk socialization
The gradual familiarization with risks in the life-long process of learning to come to terms with the environment. Development of specific attitude patterns towards risk sources
- Components of risk
The consequences of a risk source can be classified into the following categories: direct, indirect, intangible and symbolic hazards or benefits (see Page 99)
- Qualitative risk characteristics
Features which are characteristic of the concomitant circumstances of risks but which are not related to the level of the risk (e.g. voluntariness, control possibility, etc.)

Risky Shift
Phenomenon in group experiments: the group as a whole shows a higher degree of risk propensity than do its members when making individual decisions. The converse, known as the "Cautious Shift" can, of course, also occur

Salient Beliefs
cf. Belief

Satisficing Strategy
Decision-making process which is not concerned with optimization but with fulfilling minimum conditions

Self-Perception
cf. Perception

Semantic Differential
Technique for measuring the affective evaluation of beliefs regarding persons or objects

Semantic Reduction
Simplification of complex conditions by the allocation of associative attributes which are affectively loaded (e.g. male, female)

Sensibility Studies
Important technique in systems analysis for describing changes in output variables when the input variables are shifted within credible limits

Significant Other
Person whose opinion about oneself one values

Social (Political) Exchange System
The social and political powers of a society are regarded as a system which depends for its maintenance and functioning capacity on the existence and functioning capacity of the remainder of the system. In spite of the mutual dependence, the exchange need not be symmetrical, i.e. there are possibilities e.g. privileges, for profiting more than one is obliged to give (refer also to Inadequate Reciprocal Exchange)

Social Resources
Power of disposal of a group or an institution of means of social influence (e.g. access to mass media)

Socio-Receptive Reinforcement
Reinforcement of behaviour or thought patterns by the perception of social rewards (such as more prestige, recognition)

Spearman
cf. Correlation

Squared Correlation Values
cf. Correlation

Stratification
In this study, stratum is understood to mean the social prestige of a person. This is measured by income, level of education and professional prestige

Subconscious Mechanism
Forms of cognitive conclusion-drawing process where the decision-making process is not voluntarily controlled

Subjectively Expected Utility (SEU)
Central concept of decision-making theory. It means the subjectively determined benefit (or detriment) which an individual believes he will gain or lose from an action

Suppressed Anxieties
cf. Anxieties

Symbolic Reduction Theory
Psychological theory according to which people perceive objects in their environment more easily and rearrange them with less difficulty if they are able to allocate them key attributes (e.g. nuclear power = big business)

System Analysis Theory
Meta-theory used in many branches of science according to which phenomena to be explained are seen as elements of systems (or as systems themselves) which have a set order within their system and which, as a whole, can affect other systems

Three-Dimensional Factor Analysis
cf. Factor Analysis

Typological Decision Analysis
cf. Decision Analysis

Tau cf. Correlation

T-Test
Statistical process for finding out whether there is a significant difference between the mean values of two random samples, i.e. whether their difference can with all probability no longer be explained by coincidence

Values
General orientation points for the behaviour of individuals and groups
- Materialistic values (quantitative)
  Values which refer in particular to the acquisition of material goods
- Post-materialistic values (qualitative)
  Values which refer in particular to the quality of the environment and to living conditions

Value Reflection Crisis
cf. Crisis

Value Tree Analysis
Process whereby the value beliefs of groups participating in decision-making or affected by the decisions made are elicited and are spread out to such an extent that conclusions can be drawn regarding consequences relevant to the decision

Value Pluralistic Society
Society in which value systems compete with one another as universal solutions

Weighted Beliefs
cf. Beliefs

R E F E R E N C E S

1) Aachener Nachrichten: Windräder passen nicht in die Eifel
Meldung vom 24. Januar 1980

2) Adkins, M. u.a.: Public Involvement in Decision Making Related to Advanced Technologies such as Nuclear Power. OECD-Papier, unveröffentlichtes Manuskript. Paris 1972

3) Agraphiotis, D.; Pages J.: Le Nucleáire et les thêmes d'actualité essai de classification. In: Colloque sur les implications psycho-sociologiques du developpment de l'industrie nucleáire. Paris 13-15. Januar 1977

4) Agraphiotis u.a.: Le public et le nucleaire. IAEA-CN-36/254 Report. International Atomic Energy Agency. Wien 1977

5) Alemann, U.v. (Hrg): Partizipation-Demokratisierung-Mitbestimmung Eine Einführung. Opladen 1975

6) Alemann, U.v.: Partizipation - Überlegung zur normativen Diskussion und empirischen Forschung. In: Bürgerbeteiligung und Bürgerinitiativen, hrg. von H. Matthöfer. Villingen 1977

7) Alfven, H.: Energy Policy and Public Acceptance. IAEA-CN-36/588, Vortrag auf der International Conference on Nuclear Power and Its Fuel Cycle. Salzburg, 2.-13. Mai 1977.

8) Allport, G.W.: Attitudes. In: A Handbook of Social Psychology. Clark University Press 1935, S.798-844

9) Altner, G.: Der Philosoph und die Macht. In: Zeit zum Umdenken, hrg. von S. de Witt und H. Hatzfeld. Reinbek 1979, S.54-60

10) Altner, G.: Kirche und Kernkraftwerke - Grundsätze und Erfahrungen In: Kernenergie, Mensch, Umwelt, hrg. von K. Öser u.a. Köln 1976, S.15ff

11) Amery, C.: Natur als Politik. Die ökologische Chance des Menschen. Reinbek 1976

12) Amery C.: Das zweite Netz - Ein Vorschlag in die Energielücke hinein. In: Überleben ohne Wirtschaftswachstum? hrg. von der evangelischen Akademie Arnoldsheim und der Stiftung Mittlere Technologie. Karlsruhe 1977, S.51-67

13) Andritzky, E. W., Wahl-Terlinden, U.: Mitwirkung von Bürgerinititativen an der Umweltpolitik. Forschungsbericht 77, hrg. vom Institut für Zukunftsforschung im Auftrag des Umweltbundesamtes. Berlin 1978

14) Andritzky, W.: Erstmals wissenschaftlich untersucht: Bürgerinititativen. In: Bild der Wissenschaft, Nr. 2, 1978, S.84-94

15) Arbeitsgemeinschaft für Umweltfragen e.V. (Hg.): Bürgerinititative Umweltschutz - Analyse einer Fragebogenaktion. Bonn 1975.

16) Armbruster, B., Leisner, R.: Bürgerbeteiligung in der Bundesrepublik. Zur Freizeitaktivität verschiedener Bevölkerungsgruppen in ausgewählten Beteiligungsfeldern (Kirchen, Parteien, Bürgerinitiativen und Vereinen). Göttingen 1975.

17) Arminger, G.: Faktoranalyse. Studienskripte zur Soziologie, Bd.3. Stuttgart 1979.

18) Atkinson, J.: Handbook for Interviewers. London 1971.

19) Autorenkollektiv: Zum richtigen Verständnis der Kernindustrie - 66 Erwiderungen. SAIV, Uni.Bremen. Bremen 1975.

2o) Back, H.W., Gergen, K.J.: Apocalyptic and Serial Time Orientations and the Structure of Opinions. In: Public Opinions Quarterly, Vol. XXVII, Nr.2, 1963.

21) Bahr, D.-D.: Kritik der "Politischen Technologie". Frankfurt 1970.

22) Baldewicz, W. u.a.: Historical Perspectives on Risk for Large-Scale Technological Systems. UCLA-ENG-7485. School for Engineering and Applied Science. Los Angeles 1974.

23) Barnett, H.G.: Innovation: The Basis of Cultural Change. New York 1953.

24) Barnett, H.G.: Wer nimmt Neuerungen an und wer lehnt sie ab? In: Soziologie der Entwicklungsländer, hrg. von Peter Heinz. Köln, Berlin 1962, S.73-109.

25) Battelle-Institut (Hrg): Einstellung und Verhalten der Bevölkerung gegenüber verschiedenen Energiegewinnungsarten. Band 1 und Band 2, Bericht für das Bundesministerium für Forschung und Technologie. Frankfurt/Main 1977.

26) Battelle-Institut: Untersuchungen über die technischen, organisatorischen und gesellschaftlichen Vorsaussetzungen für Risikostrategien im Bereich technologischer Entwicklung. Präsentation des Projektes im Bundesinnenministerium. 11. Mai 1978, RSI2-510 120/4-3-1/1. Bonn 1978.

27) Beckmann, P.: The Health Hazards of Not Going Nuclear. Boulder (Colorado, USA) 1976.

28) Benninghaus, H.: Soziale Einstellungen und soziales Verhalten. In: Soziologie-Sprache, Bezug zur Praxis, Verhältnis zu anderen Wissenschaften, hrg. von G. Albrecht u.a.. Opladen 1973, S.671-7o7.

29) Berger, H.: Untersuchungsmethode und soziale Wirklichkeit. Frankfurt/Main 1974.

30) Bernt, H.: Kernenergietechnik und Monopolkapital. In: IPW-Berichte, Bd.1, Berlin 1974, S.39-43

31) Bethe, H.A.: The Controversy About Nuclear Power. IAEA-CN-36/582. Vortrag auf der International Conference on Nuclear Power and Its Fuel Cycle. Salzburg, 2-13. Mai 1977.

32) Bick, Th., Kasperson, R.E.: Pitfalls of Hazards Management. In: Environment, Vol.20, Nr.8, Oktober 1978, S.30ff.

33) Bieber, H.-J.: Zur politischen Geschichte der friedlichen Kernenergienutzung in der Bundesrepublik Deutschland. Materialien zum Gutachten der FEST, "Alternative Möglichkeiten für die Energiepolitik". Band 3. Heidelberg 1977.

34) Bierbrauer, G.: Intuitive Erklärungen und Prognosen. Eine sozialpsychologische Analyse zur Legitimation politischer Planung. In: Bürgerbeteiligung und Bürgerinitiativen, hrg. von H. Matthöfer. Villingen 1977, S.66-87

35) Bierbrauer, G.: Die Zuschreibung von Verantwortlichkeit. Eine attributionstheoretische Analyse. In: Sozialwissenschaften im Studium des Rechts. Strafrecht und Kriminologie, hrg. von W. Hassener und L. Luderssen. München 1977.

36) Blau, P.: Exchange and Power in Social Life. New York 1964

37) Bloch, E.: Das Prinzip Hoffnung. Frankfurt 1959

38) Borsdorf-Rühl, B.: Bürgerinititativen im Ruhrgebiet. Essen 1973

39) Borsch, P., Münch, E.: Die Sicherheit von Kernkraftwerken. In: Nutzen und Risiko der Kernenergie. Jül-Conf-17 der Kernforschungsanlage Jülich GmbH. Jülich 1978.

40) Borsch, P., Münch, E.: Die Sicherheit von Kernkraftwerken. In: Tatsachen über Kernenergie, hrg. von E. Münch, Essen 1980.

41) Bowmann, C.H. u.a.: The Prediction of Voting Behaviour in a Nuclear Energy Referendum. International Institute for Applied Systems Analysis. RM-78-8. Laxenburg (Österreich) 1978.

42) Brown, H.: Learning how to live in a technological society. Teil I: The Crisis of Affluence. Teil II: Toward a World Community. In: The Bulletin of the Atomic Scientists, Vol.35, Nr.8, September 1979, S.13ff und Oktober 1979, S.23ff.

43) Buchholtz, H.-Chr. u.a. (Hrg): Widerstand gegen Atomkraftwerke. Informationen für Atomkraftgegner und solche, die es werden wollen. Wuppertal 1978.

44) Büchel, W.: Gesellschaftliche Bedingungen der Naturwissenschaft. München 1975.

45) Burdge, R.J.: Ludtke, R.L.: Social Separation Among Displaced Rural Families: The Case of Flood Control Reservoirs. In: Social Behavior. Natural Resources and the Environment, hrg. von W.R.Burch u.a.. New York 1972, S.85-107.

46) Buiren, S.van: Bürgerinitiativen im Bereich von Kernkraftwerken. Bericht des Deutschen Battelle Instituts für das Ministerium für Forschung und Technologie. Bonn 1975.

47) Burnham, J.B. u.a.: Quantified Social and Aesthetic Values in Environmental Decision Making. In: Siting of Nuclear Facilities. IAEA-SM-188/43. Wien 1975.

48) Buse, M., Nelles, W.: Formen und Bedingungen der Partizipation im politisch/administrativen Bereich. In: Partizpation-Demokratisierung-Mitbestimmung, hrg. von U. von Alemann. Opladen 1975, S.41-111.

49) Campbell, D.T.; Stanley, J.C.: Experimental and quasi-experimental designs for research on teaching. In: Handbook of Research on Teaching. Chicago 1963, S.171-246.

50) Campbell, D.T. u.a.: Experimental Methods. Englewood Cliffs 1972

51) Cantril, H.: The Patterns of Human Concern. New Brunswick 1965

52) Chandler, R.: Public Opinion: Changing Attitudes on Contemporary Political and Social Issues. New York, London 1972.

53) Chester, H.: Perception and Cognitive Theory. London 1964.

54) Cohen, B.L.: Perspectives on the Nuclear Debate. In: The Bulletin of the Atomic Scientists. Nr. 30, 1974, S.25-39.

55) Cohen, B.L.: Some Issues in the Nuclear Power Controversy. In: Public Utility Fortnight 98, Nr.4, August 1976.

56) Cole, W.S.: Atomic Energy: Its Implications for Society. In: High Points, Nr. 37, 1955. S.5-11.

57) Combs, B.; Slovic, P.: Causes of Death: Biased Newspaper Coverage and Biased Judgements. Manuscript: Journalism Quarterly, Decision Research Report 78-8. Eugene (Oregon) 1978.

58) Comey, D.D.: Social Stability and Nuclear Energy. Vortrag auf Int. Symposium: Nuklearindustrie in der Krise. Rueschlikon (Schweiz) 26-28.2.76.

59) Conrad, J.: Zum Stand der Risikoforschung. Bericht des Battelle-Instituts im Auftrag des Bundesministerium des Innern. Bericht Nr. 100/3. Frankfurt 1978.

60) Coombs, C.H.: A Review of the Mathematical Psychology of Risk and Risk Taking. Michigan-University-Report 72-6. Michigan 1972.

61) Coser, L.: Conflict-Social Aspects. In: International Encyclopedia of the Social Sciences, Vol.3. New York 1968, S.232-236.

62) Courvoisier,P.: Vom Sinn der Information der Öffentlichkeit über hochkomplexe Technologien. Schweizerische Vereinigung für Atomenergie. Beilage zu Bulletin Nr. 5, März 1974.

63) Dahl, J.: Auf Gedeih und Verderb. Zur Metaphysik der Atomenergie-Erzeugung. In: Scheidewege, 5, 1975, S.201-226.

64) Dumazedier, J.: Leisure and Post-Industrial Societies. In: Technology, Human Values und Leisure, hrg. von M. Kaplan and Ph. Bosserman. Nashville, New York, 1971.

65) Dawes, R.M.: Formal Models of Dilemmas in Social Decision-Making In: Human Judgement and Decision Processes. New York 1975. S.87-129.

66) Dawes, R.M.: Grundlagen der Einstellungsmessung. Weinheim/Basel 1972.

67) Davies, J.E.O.: Canadian Attitudes to Nuclear Power. IAEA-CN-36/580. Vortrag auf der International Conference on Nuclear Power and Its Fuel Cycle. Salzburg, 2.-13. Mai 1977.

68) Davies, J.E.O.: Recent Public Attitudes to Nuclear Power. Lecture at the 15th Annual Conference of the Canadian Nuclear Association. Ottawa 1976.

69) Declaration of the European Nuclear Society vom 6. Mai 1977: Offener Brief an die Öffentlichkeit. Salzburg 1977.

70) De Fleur, M.L.; Westie, F.R.: Verbal Attitudes and Overt Acts: An Experiment on the Salience of Attitudes. American Sociological Review, Nr. 23, 1958, S.667-673.

71) Denenberg, H.S.: Nuclear Power: Uninsurable. Congressional Report November 25, Washington, D.C.: U.S.Government Printing Office 1974.

72) Deutsche-Presse-Agentur (DPA-Umweltfragen): Die "Grünen" jetzt als Bundespartei - Aber noch kein Programm. Umweltfragen, Nr.1, 17.o1.1980, S.1-5.

73) Deutscher Bund für Lebensschutz: Kritischer Bericht zum Expertengespräch über Reaktorsicherheitsforschung. In: Energiediskussion, hrg. vom Bundesministerium für Forschung und Technologie. Nr.6/7, Dezember 1978, S.60ff.

74) Dickson, D.: Alternative Technologie. Strategien der technischen Veränderung. München 1978.

75) Dienel, P.C.: Zur Entwicklung eines Verfahrens geordneter bürgerschaftlicher Planungsbeteiligung. In: Analysen und Prognosen, Nr.45, hrg. vom Zentrum Berlin für Zukunftsforschung. Berlin 1976.

76) Diepold W., Krebsbach, C.: Versuch zur Erfassung von Risikomaßstäben und Definitionen. Teil A aus technischer, Teil B aus gesellschaftlicher Sicht. Bericht für das Bundesministerium des Innern, hrg. vom Battelle-Institut Frankfurt. Teilbericht 100/2. Frankfurt 1977.

77) Døderlein, J.M.: The Nuclear Controversy International. Vortragsmanuskript der KFG-Veranstaltung über "Kernenergie und Umwelt". Geesthacht 14.3.1975.

78) Døderlein, J.M.: Nuclear Power and Society - Generalizations from the European Scene. In: Socioeconomic Issues for Nuclear Plants. Invited Paper. Konferenz der American Nuclear Society. Washington D.C. 14.11.1976, S.98.

79) Døderlein, J.M.: Nuclear Power as a Public Issue. IAEA-CN-36/451. Vortrag auf der International Conference on Nuclear Power and Its-Fuel Cycle. Salzburg, 2.-13. Mai, 1977.

80) Døderlein, J.M: Society, Risk and Nuclear Power. Vortrag vor dem Hahn-Meitner-Institut in Berlin, März 1978.

81) Douglin, J.J.: The Anti-Nuclear-Movement and Its Critics. The Social Base of Support. Vortrag auf dem Seminar for Industry Spokesmen. Toronto, 9. November 1976.

82) Douvan, E., Withey, S.: Public Reactions to Nonmilitary Aspects of Atomic Energy. In: Science, Nr.119, Jahrgang 1, 1954, S.1-3.

83) Downs, A.: An Economic Theory of Democracy. New York 1957.

84) Downs, A.: Up and Down with Ecology - The 'Issue-Attention-Cycle'. In: The Public Interest, Nr.28, 1972, S.38-50.

85) Dumenil, G.: Energie nucleaire et opinion publique. Analyse des rêsults de quelques. Report No.2. ADISH/IREP. Paris/Grenoble 1977.

86) Dunster, H.J.; Vinck, W.: The Assessment of Risk - Its Value and Limitations. Vertrag auf der: Conference of the European Comission on Technological Risk. Berlin, 1-3. April 1979, abgedruckt in: Monitor-Nuclear Engineering International, August 1979, S.23ff.

87) Duttweiler, G.: Social Stability and Nuclear Energy. Lecture at the Symposium: Nuklearindustrie in der Krise. Rüschlikon, Februar 1976.

88) Duve, F.: Zur Einführung - Demonstranten oder Dissidenten. In: Bürger gegen Kernkraftwerke, von H. H. Wüstenhagen, Hamburg 1975.

89) Ebbighausen R.: Die Krise der Parteiendemokratie und die Parteiensoziologie. Berlin 1969

90) Eberwein, W.-D.: Krise und Konflikt - Zum Stand der Theorie. Fachgebiet Politikwissenschaft der Universität des Saarlandes. Forschungspapiere Nr.4. Saarbrücken, Juni 1973.

91) Edwards, A.L.: Versuchsplanung in der psychologischen Forschung. Weinheim 1971.

92) Edwards, W.: The Theory of Decision Making. In: Psychological Bulletin, Nr. 51, 1954, S.380-417.

93) Electricité de France: Themes d'actualité et themes d'expression, Bd. 1-4. Paris 1977

94) Ellwein, T., Lippert, E., Zoll, R.: Politische Beteiligung in der Bundesrepublik. Göttingen 1975.

95) Ellul, J.: The Technological Society. Vintage Books. New York 1964 (original 1954)

96) Engelmann, P.A., Renn, O.: On the Methodology of Cost-Benefit-Analysis and Risk Perception. In: Directions in Energy Policy. A Comprehensive Approach to Energy Resource Decision-Making, hrg. von B. Kursunoglu und A. Perlmutter. Cambridge (Mass) 1980

97) Eichholz, G.: Cost-Benefit and Risk-Benefit Assessment for Nuclear Power Plants. In: Nuclear Safety, Vol.17, Nr.5, September/Oktober 1976, S.525ff.

98) Eisenbart, C.: Außenpolitik und Kernenergie. In: Alternative Möglichkeiten für die Energiepolitik. Materialien zum Gutachten. Band 2, hrg. von W. Lienemann u.a.. Heidelberg 1977, S.291-322.

99) Eisenhart, G.: Krebsbach, C.: Stereotype Wahrnehmung. Ihr Einfluß auf Interaktion und Kommunikation im Bereich politischer Planung von großtechnischen Einrichtungen. Auftrag des Bundesministerium des Innern, hrg. vom Battelle-Institut Frankfurt. Bericht 400/3. Frankfurt 1978.

100) Erbslöh, E.: Das Interview. Techniken der Datensammlung, Bd.1. Stuttgart 1972.

101) Eroufman, L.M., Mattingly, T.J.: Critical Mass: Politics, Technology and the Public Interest. In: Nuclear Safety, Band 17, Nr. 5, 1976.

102) Erskine, H.G.: The Polls: Atomic Weapons and Nuclear Energy. In: The Public Opinion Quarterly, Nr.2, 1963

103) Esser, H.: Soziale Regelmäßigkeiten des Befragtenverhaltens. Meisenheim 1975.

104) Esser, H.; Klenovits, K.; Zehnpfennig, H.: Wissenschaftstheorie. Band 1 und Band 2, Teubner Studienskripte, hrg. von E.K. Scheuch und H. Sahner. Stuttgart 1977.

105) Farmer, F.R.: Risk Quantification and Acceptability. In: Nuclear Safety, Vol.17, Nr.4, Juli-August 1976, S.418ff.

106) Felix, F.: The Socioeconomic Challenges of the Energy/Income Relationship. Lecture at the Conference on Energy Development. Washington, Februar 1976.

107) Festinger, L.: A Theory of Cognitive Dissonance. Evanston, Ill.(USA) 1957.

108) Flora, P.: Modernisierungsforschung. Opladen 1974.

109) Fischerhoff, H.: Das Kernenergierisiko - Seine Einschätzung und seine Annahme. Vortrag auf dem AIDN-INCA-Kongress: Nuclear Inter Jura, 2-5. Oktober 1977.

110) Fischhoff, B.: Cost-Benefit-Analysis and the Art of Motorcycle Maintenance In: Policy Sciences, Bd.8, 1977, S.177-202.

111) Fischhoff, B.: Behavioral Aspects of Cost-Benefit-Analysis. Vortrag auf dem International Review Seminar on "Impacts and Risks of Energy Strategies". Stockholm, 26-29. September 1978.

112) Fischhoff, B.u.a.: How Safe is Safe Enough? A psychometric study of attitudes towards technological risks and benefits. In: Policy Sciences, Nr.9, 1978, S.127-152.

113) Fischhoff, B.u.a.: Handling Hazards. In: Environment, Vol.20, Nr.7, September 1978, S.16ff.

114) Fischhoff, B.; Slovic, P.; Lichtenstein, S.: Weighing the Risks. Which Risks Are Acceptable? In: Environment, Vol.21, Nr.4, Mai 1979, S.17ff.

115) Fishbein, M. (Hrg): Readings in Attitude Theory and Measurement. New York 1967.

116) Fishbein, M.: The Relation between Beliefs, Attitudes and Behavior. In: Cognitive Consistency, hrg. von S. Feldmann. New York 1966, S.199-233.

117) Fishbein, M.; Ajzen, J.: Belief, Attitude, Intention and Behaviour: An Introduction to Theory and Research. Reading (Mass) 1975.

118) Fisher, B.; Mitzner, R.; Darsky, B.J.: Peacetime Uses of Atomic Energy. Ann Harbor 1951.

119) Forschungsgruppe an der FU in Berlin: Zur Rolle und Funktion von Bürgerinititativen in der Bundesrepublik und West-Berlin. Analysen von 61 Bürgerinitiativen. In: Zeitschrift für Parlamentsfragen 4, 1973, S.247ff.

120) Frantzen, D.; Schmid-Jörg.: Sozialwissenschaftliche Untersuchungen über das Wahrnehmungsfeld der Bevölkerung im Bereich technologischer Risiken (hier Kernkraftwerke). Bericht für das Bundesministerium des Innern, hrg. vom Battelle-Institut Frankfurt. Zwischenbericht 4001. Frankfurt 1976.

121) Freyer, H.: Die Technik als Lebensmacht, Denkform und Wissenschaft. Mainz 1970.

122) Friedrich, W.: Methoden der marxistisch-leninistischen Sozialforschung. Berlin (Ost) 1972.

123) Friedrichs, J.: Methoden der empirischen Sozialforschung. Reinbek 1973

124) Fürniß, B. u.a.: Optimierung eines regionalen Energieversorgungssystems bei mehrfacher Zielsetzung. In: Energiewirtschaftliche Tagesfragen, Heft 3, März 1980, S.155ff.

125) Fürstenberg, F.: Die Sozialstruktur der Bundesrepublik Deutschland. Ein soziologischer Überblick, 2. Auflage. Opladen 1972.

126) Garrisson, J.: The Religious Background of the Nuclear Controversy. Dissertation, Trinity College. Cambridge 1977.

127) Gehlen, A.: Die Seele im technischen Zeitalter. Sozialpsychologische Probleme in der industriellen Gesellschaft. Hamburg 1957.

128) Gesellschaft für Reaktorsicherheit (Hrg): Die Deutsche Risikostudie. Kurzfassung. Bonn, 8. August 1979.

129) Gillian, H.: Jobs versus Environment. In: San Francisco Examiner and Chronicle, 10, Dezember 1972, S.41.

130) Gittler, J.B.: Social Trends and Atomic Energy. In: Social Science 28, 1953, S.67-71.

131) Goerke, D.: Untersuchung und Ausarbeitung von Maßnahmen zur Öffentlichkeitsarbeit bei Erörterungsterminen über den geplanten Bau kerntechnischer Anlagen. Auftrag des Bundesministeriums des Innern. Vechta 1975.

132) Goerke, D.: Meinungsbildung in der Öffentlichkeit über energiepolitische Fragen, insbesondere im Bereich der Kernenergie-Sicherheit. Auftrag des Bundesministeriums des Innern. Vechta 1978.

133) Gorz, A.: Ökologie und Politik. Beiträge zur Wachtsumkrise. Reinbek 1977

134) Golant, S., Burton, B.: Advoidance Response to the Risk Environment. Research Working Paper Nr.6, Dept. of Geography. University of Toronto 1969.

135) Golden, J., Watson, J.: Socio-Economic and Ecological Impacts of Nuclear Power Plants. Mc Lean (Virg.USA) 1975.

136) Gonschior, P.: Die Berücksichtigung des technischen Fortschritts in Projektionen des wirtschaftlichen Wandels. In: Analysen und Prognosen, hrg. von Zentrum für Zukunftsforschung e.V., Heft 45, Mai 1976

137) Gottstein, K.: Die nukleare Kontroverse in den USA. Vortrag bei der Mitgliederversammlung des Deutschen Atomforums e.V.. Bonn November 1975.

138) Gottstein, K.: Technikkritik und Technikkontrolle. In: Physikalische Blätter, Band 35, Heft 6. Juni 1979, S.237ff.

139) Graumann, G.F.: Eigenschaften als Problem der Persönlichkeitsforschung. In: Handbuch der Psychologie, hrg. von Ph. Lersch und H. Thomae. Band 4. Göttingen 1960.

140) Greenhalgh, G.: The Opposition to Nuclear Power. An Appreciation of the Uranium Institute. London 1978.

141) Greer-Wootten, B., Mitson, L.: Nuclear Power and the Canadian Public. A National and Regional Assessment of Public Attitudes and Perceptions of the Use of Nuclear Power for the Production of Electricity. Institute for Behavioural Research, York University. Toronto 1976.

142) Gripp, H.: Die Suche nach einem Neuen Lebensstil - ein sinnvoller Ausweg aus einem gesamtgesellschaftlichen Dilemma? In: Neuer Lebensstil, Verzichten oder Verändern?, hrg. von K.E. Wenke und H. Zilleßen. Opladen 1978, S.248-289.

143) Gruhl, H.: Kernenergie ohne soziale Legitimation: In: Kernenergie - offen bilanziert, hrg. vom Gottlieb Duttweiler-Institut für wirtschaftliche und soziale Studien. Frankfurt a.M. 1976, S.113-121.

144) Gruhl, H.: Ein Planet wird geplündert - Die Schreckensbilanz unserer Politik. Frankfurt/M. 1975

145) Grupe, H.: Gedanken zur nuklearen Kontroverse in der Bundesrepublik Deutschland. In: Kerntechnik-Atompraxis, 18. Jhrg. Nr.7, Juli 1976, S.317-320

146) Guggenberger, B.; Kempf, U.(Hrg): Bürgerinitiativen und repräsentatives System. Opladen 1978

147) Gutmann, G.: Sozialisation von Risikoeinstellungen, bearbeitet vom Battelle-Institut Frankfurt für das Bundesministerium des Inneren, Nr. 401. Frankfurt 1977.

148) Haas, J.E.; Boggs, K.S.; Bonner, E.J.: Science,Technology and the Public. The Case of Planned Weather Modification. In: Social Behavior, Natural Resources and the Environment, hrg. von W.R. Burch u.a.. New York, Evanston, San Francisco, London 1972, S.151-173.

149) Habermas, J.: Legitimationsprobleme im Spätkapitalismus. Frankfurt/Main 1973.

150) Habermas, J.: Technik und Wissenschaft als Ideologie. Frankfurt/Main 1968.

151) Habermas, J., Luhmann, N.: Theorie der Gesellschaft. Frankfurt a.M. 1975

152) Hackmann, J.R.; Anderson, L.R.: The Strength, Relevance and Source of Beliefs about an Object in Fishbein's Attitude Theory. In: Journal of Social Psychology, Nr.76, 1968, S.55-67

153) Häfele, W.: Hypotheticality and the New Challenges, The Pathfinder Role of Nuclear Energy. Laxenburg. International Institute for Applied Systems Analysis (IASA). RR-73-14. Laxenburg 1973.

154) Häfele, W.: Die historische Entwicklung der friedlichen Nutzung der Kernenergie. In: Kernenergie und internationale Politik, hrg. von K. Kaiser und B. Lindemann. Reihe: Internationale Politik und Wirtschaft, Bd.37. München, Wien, Oldenburg 1975.

155) Haenschke, F.: Modell Deutschland? Die Bundesrepublik in der technologischen Krise. Reinbek 1977.

156) Hamilton, L.D.; Manne, A.S.: Health and Economic Costs of Alternative Energy Sources. IAEA-CN-36/448. Vortrag auf der International Conference on Nuclear Power and Its Fuel Cycle. Salzburg, 2.-13.Mai 1977.

157) Hansmeyer, K.H.; Rürüp, R.: Staatswirtschaftliche Planungsinstrumente. Wiso Studienbücher, 2. Auflage. Tübingen 1975.

158) Harder, Th.: Werkzeuge der Sozialforschung. Bielefeld 1970.

159) Harnik, P.: The Ethics of Energy Production and Use: Debate within the National Council of Churches. In: The Bulletin of the Atomic Scientists, Nr.2, Februar 1979, S.5-8.

160) Harriss, R.C. u.a.: Our Hazardous Environment. In: Environment, Vol.20, Nr.7, September 1978, S.6ff.

161) Hartkopf, G.: Risiko der Kernenergie. In: liberal, Heft 6, 18. Jhrg. Juni 1976.

162) Harvey, M.: Project Summary: Improving the Societal Management of Technological Hazards. National Science Foundation. Juni 1979.

163) Heintz, P. (Hrg): Soziologie der Entwicklungsländer, Köln 1962.

164) Heintz, P.: Die Zukunft der Entwicklung. Wien 1974.

165) Helfen, D., Laga, G.: Messung sozialer Schichtung. In: Kölner Zeitschrift für Soziologie und Sozialpsychologie, hrg. von R. König, Jg.26, Heft 1, 1974.

166) Herz, Th.: Der Wandel von Wertvorstellungen in westlichen Industriegesellschaften. In: Kölner Zeitschrift für Soziologie und Sozialpsychologie, hrg. von R. König, Jg.31, Heft 2, 1979, S.282-302.

167) Hewitt, J.S.: Educational Responsibility in the Canadian Nuclear Controversy. In: Trans. American Nuclear Society. November 1976, S.73-74.

168) Hinz, M.O.: Widerstand gegen das Atomprogramm - Krise des Rechtsstaates? Referat auf dem Kernenergie-Seminar des Bundes für Lebensschutz. Lüneburg, 17. u. 18.09.1977.

169) Hirsch, H.: The 'Information Campaign on Nuclear Energy' of the Austrian Government. Preliminary Survey. IAEA-CN-36/589. Vortrag auf der International Conference on Nuclear Power and Its Fuel Cycle. Salzburg, 2.-13.Mai 1977.

170) Hirsch, J.: Wissenschaftlich-technischer Fortschritt und politisches System. Frankfurt/Main 1971.

171) Hirshleifer, J. u.a.: Applying Cost-Benefit Concepts to Projects which Alter Human Mortality. Los Angeles 1974.

172) Hofstätter, P.R.: Der Teufel aus der Maschine. Warum wir heute noch die Technik fürchten. In: Die Welt, 7.Juli 1979.

173) Hohenemser Chr. u.a.: The Distrust of Nuclear Power. In: Science, Vol.196, April 1977, S.25-34.

174) Holm, K.(Hrg.): Die Befragung 1. Der Fragebogen - Die Stichprobe. München 1975.

175) Huber, J.: Technokratie oder Menschlichkeit. Zur Theorie einer humanen und demokratischen Systementwicklung. Achberg 1978.

176) Hülsmann, H.: Verantwortung von Wissenschaft - von Manhatten zu Wyhl. Meisenheim/Glan 1977

177) Hülsmann, H.: Die Machtergreifung - Zur Verantwortbarkeit von Wissenschaft, Forschung und Technologie. In: Die atomare Gesellschaft. Grundlage für den Dialog um die Kernfrage. Darmstadt und Neuwied 1978, S.147-162.

178) Hülsmann, H.; Tschiedel, R.(Hrg): Kernenergie und wissenschaftliche Verantwortung. München 1978.

179) Hunecke, H.: Experimentelle Untersuchungen zum Problem des Zusammenhangs zwischen erfragten und beobachteten Verhalten. Dissertation. Universität Heidelberg 1972.

180) Illich, J.: Die sogenannte Energiekrise oder Die Lähmung der Gesellschaft. Das sozial kritische Quantum der Energie. Reinbek 1977.

181) Inglehart, R.: The Silent Revolution in Europe. Intergenerational Change in Post-Industrial Societies. In: American Political Science Review, 65, 1971, S.991-1017.

182) Inglehart, R.: Values, Objective Needs, and Subjective Satisfaction Among Western Publics. Comparative Political Studies 9, 1977, 4, S.428-458

183) Inglehart, R.: Zusammenhang zwischen sozioökonomischen Bedinqunqen und individuellen Wertprioritäten. In: Kölner Zeitschrift für Soziologie und Sozialpsychologie, Bd.1, März 1980, S.144ff.

184) Inhaber, H.: Scientists and Economic Growth.In: Social Studies of Science, Vol.7, Nr.4, November 1977, S.517-524.

185) Inhaber, H.: Risk of Energy Production. Atomic Energy Control Board 1119 REV-1, 2. Auflage. Ottawa (Canada) 1978.

186) Jungk, R.: Der Atomstaat. Vom Fortschritt in die Unmenschlichkeit. München 1977.

187) Jungk, R.: Vom 1000jährigen Atomreich. In: Der Spiegel, Heft-Nr.11, 1977, S.44ff.

188) Kaase, M.: Bedingungen unkonventionellen politischen Verhaltens in der Bundesrepublik Deutschland. In: Legitimationsprobleme politischer Systeme, hrg. von P. Kielmansegg. Politische Vierteljahresschrift, 17, 1976, Sonderheft 7, S.179-216

189) Kafka, P.; Münch, E.: Risikokonzept. Zur Einführung und Diskussion. In: KTG-Fachseminar. Störfallverhalten an Leistungsreaktoren. Jülich, 23.-26.11.1976.

190) Kahneman, D., Tversky, A.: Inituitive Prediction: Biases and Corrective Procedures. Manuskript. Hebrew -University. Jerusalem 1978.

191) Kahneman, D., Tversky, A.: Subjective Probability: A Judgement of Representativeness. In: Cognitive Psychology, Band 2, 1972, S.430-454.

192) Kahneman, D., Tversky, A.: On the Psychology of Prediction. In: Psychological Review Nr. 80, 1973, S.237-251.

193) Kahneman, D.; Tversky, A.: Availibility: A heuristic view for judging frequency and probability. In: Cognitive Psychology, Nr. 5, 1973, S.207-232.

194) Kaplan, K.J.; Fishbein, M.: The Source of Beliefs, their Saliency and Prediction of Attitude. In: Journal of Personality and Social Psychology, Nr.19, 1969, S.92-99.

195) Kaspar, R.: "Real" versus Perceived Risk: Implications for Policy. Manuscript. In: Impacts and Risks of Energy Strategies. Their Analysis and Role in Management. Proceedings of the Conference. Stockholm 1978.

196) Kates, R.W.: Hazard and choice perception in flood plain management (Research Paper No. 78) Chicago: University of Chicago. Department of Geography 1962.

197) Kates, R.W.: Risk Assessment of Environmental Hazard. SCOPE-Report, Nr.8. International Council of Scientific Unions. Paris 1976.

198) Katz, E.; Lazarsfeld, P.: Personal Influence. Glencoe (Ill.USA) 1955

199) Katz, E. u.a.: Traditions of research on the diffusion of innovation. In: American Sociological Review, Nr. 28, April 1963, S.237-252.

200) Keiser, G.: Die Energiekrise und Strategien der Energiesicherung. München 1979.

201) Kempf, U.: Bürgerinitiativen - der empirische Befund. In: Bürgerinitiativen und repräsentatives System, hrg. von B. Guggenberger und U. Kempf. Opladen 1978, S.358-374.

202) Kernenergie und internationale Politik, hrg. von K. Kaiser und B. Lindemann. München, Oldenburg 1975.

203) Kernenergie - offen bilanziert. Schriftenreihe: Brennpunkte Bd.4, Frankfurt 1976.

204) Keyes, G.E., Poncelet, C.G.: Adressing the Nuclear Controversy on University Campuses. IAEA-CN-36/450. Vortrag auf der International Conference on Nuclear Power and Its Fuel Cycle. Salzburg, 2.-13.Mai 1977.

205) Kielmansegg, Graf P.: Politik in der Sackgasse? Vortrag auf der wissenschaftlichen Tagung der CDU zu Umwelt und Wachstum, abgedruckt in: Energiediskussion, hrg. vom Ministerium für Forschung und Technologie. Heft 3, Juni 1979, S.31ff.

106) Klausner, S.Z.: Some Problems in the Logic of Current Man Environment Studies. In: Social Behavior, Natural Resources and the Environment, hrg. von W. Burch u.a.. York 1972, S.334-363.

107) Klineberg, O.: Social Psychology. New York 1966.

208) Kmieciak, P.: Wertstrukturen und Wertwandel in der Bundesrepublik Deutschland - Grundlagen einer interdisziplinären empirischen Wertforschung mit einer Sekundäranalyse von Umfragedaten. Veröffentlichung der Kommission für wirtschaflichen und sozialen Wandel Nr.135. Göttingen 1976.

209) Knirsch, H.P.; Nickolmann, F.: Die Chance der Büqerinitiativen. Ein Handbuch. Wuppertal 1976.

210) Kodolitsch, P. von: Gemeindeverwaltungen und Bürgerinitiativen. In: Archiv für Kommunalwissenschaften, Heft 2, 1975, S.264ff.

211) König, R.: Neue Strömungen der Gemeindesoziologie. In: Handbuch der empirischen Sozialforschung, hrg. von R. König, 3.Auflage, Bd.2. Stuttgart 1973.

212) Kommission der EG: Wissenschaft in der öffentlichen Meinung Europas. Brüssel 1978.

213) Korff, W.: Kernenergie und Moraltheologie. Der Beitrag der theologischen Ethik zur Frage allgemeiner Kriterien ethischer Entscheidungsprozesse. Frankfurt/Main 1979.

214) Krech, D., Crutchfield, R.S., Ballachey, E.L.: Individual in Society. New York, London, Sydney 1962.

215) Küchler, M.: Multivariable Analyseverfahren.Studienskripten zur Soziologie. Stuttgart 1979.

216) Kutsch, Th.: Die Welt im Jahre 2000. Analyse einer internationalen Umfrage über die Einstellung zur Zukunft. Kronberg (Taunus) 1974.

217) Lange, W.P.: Zur Rolle und Funktion der Bürgerinitiativen in der BRD. In: Zeitschrift für Parlamentsfragen. Opladen, Bd.4 Juni 1973. S.247ff

218) Lapp, R.E.: The Heart of the Nuclear Controversy. Atomic Industral Forum. AED-73-558-018. San Francisco, November 1973.

219) Lenzer, Ch.: Probleme forschungspolitischer Planung beim Bundestag. In: Technikfolgen, Technik-Abschätzung, hrg. von H.Haas. München, Wien 1975.

220) Lerner, D.: Die Modernisierung des Lebensstils: Eine Theorie In: Theorien des sozialen Wandels, hrg. von W. Zapf. Köln, Berlin 1971.

221) Levine, G.; Modell J.: American Public Opinion and Fallout-Shelter Issue. In: Public Opinion Quarterly, Nr.2, 1965, S.270-279.

222) Lindackers, K.-H.: Die Bedeutung technischer Risiken. In: Atomwirtschaft-Atomtechnik, 19, 1974, S.284-288

223) Lindblom, Ch.E.: Politics and Markets. The World's Political-Economic Systems. New York 1977.

224) Linnerooth, J.: A Critique of Recent Modelling Efforts to Evaluate Human Life. RR-75-67. International Institute for Applied Systems Analysis. Laxenburg 1975.

225) Linnerooth, J.: Methods for evaluating mortality risk. In Futures, Nr. 8, 1976, S.293-309.

226) Lob, S.: Atomenergie - Zur Struktur eines gesellschaftlichen Konfliktes. In: Kernenergie und wissenschaftliche Verantwortung, hrg. von H. Hülsmann und R. Tschiedel. Kronberg 1977. S.123-154.

127) Lovins, A.B.: Soft Energy Paths: Toward a Durable Peace. San Francisco, New York 1977.

128) Lowrance, W.W.: Of Acceptable Risk. Science and the Determination of Safety. Los Altos (Cal.) 1976.

228) Lübbe, H.: Herrschaft und Planung. Die veränderte Rolle der Zukunft in der Gegenwart. In: Festschrift für Max Müller. Freiburg 1966, S.188ff.

230) Lübbe, H.: Technischer und sozialer Wandel als Orientierungsproblem. Vortragsmanuskript. 29.o5.1979.

231) Luhmann, N.: Soziologische Aufklärung. Aufsätze zur Theorie sozialer Systeme. Band 1, 3. Auflage. Opladen 1972.

232) Luhmann, N.: Öffentliche Meinung. In: Politische Planung. Aufsätze zur Soziologie von Politik und Verwaltung; hrg. von N. Luhmann. Opladen 1971, S.9-34.

233) Luhmann, N.: Legitimation durch Verfahren. Neuwied-Berlin 1969

234) Luhmann, N.: Macht. Stuttgart 1975

235) Luhmann, N.: Vertrauen. Ein Mechanismus der Reduktion sozialer Komplexität. Stuttgart 1973.

236) Maderthaner, R.; Guttmann, G.; Swaton, E.; Otway, H.J.: Effect of Distance upon Risk Perception. In: Journal of Applied Psychology, 63 (3) S.380-382. 1978.

237) Marcuse, H.: Der eindimensionale Mensch. Neuwied/Berlin 1967.

238) Matthöfer, H.: Kernenergie und Öffentlichkeit. Rede vor der Reaktortagung in Nürnberg am 10. April 1975, veröffentlich als Sonderdruck des Presse- und Informationsamtes der Bundesregierung, aus Nr.48, S.455-458. Bonn 1975.

239) Mauss, A.L.: Social Problems as Social Movements. New York 1975 (insbesondere Chapter 15: The Environment as a Social Problem, S.556-701).

240) Maxey, M.N.: Nuclear Energy Debates: Liberation and Development. In: The Christian Century, Heft 93, Juli 1976, S.656ff.

241) Maxey, M.N.: Exorcising Nuclear Demonry: Ethics Versus Ideological Politics. Lecture at the AIF-Workshop, Nuclear Information Strategies, unveröffentlichtes Manuskript, Las Vegas 1976.

242) Mayer-Tasch, P.C.: Kernenergie und Bürgerprotest. In: Energiepolitik ohne Basis. Vom bürgerlichen Ungehorsam zu einer neuen Energiepolitik, hrg. von C. Amery, P.C. Mayer-Tasch, K.M.Meyer-Abich. Frankfurt/Main 1978, S.7-39.

243) Mayer-Tasch, P.C.: Die Bürgerinitiativbewegung. Der aktive Bürger als rechts- und politikwissenschaftliches Problem. Reinbek 1976.

244) Maynard,W.S.u.a: Public Values Associated with Nuclear Waste Disposal. Battelle Memorial Institute. BNWL-1997. Seattle, Wash. 1976.

245) Mayntz, R.; Holm, K.; Hübner, P.: Einführung in die Methoden der empirischen Sozialforschung. 2.Auflage. Opladen 1971.

246) Mazur, A.: Opposition to technological innovation. In: Minerva, Vol.13, London 1975, S.58-81.

247) Mc Evoy, J.: The American Concern with Environment. In: Social Behavior, Natural Resources and the Environment, hrg. von W. R. Burch u.a.. New York 1972, S.214-236.

248) Mc Guire, W.J.: The Nature of Attitudes and Attitude Change. In: Handbook of Social Psychology, hrg. von G. Lindzey und E. Aronson, Bd.III. Reading, Mass. 1969, S.136-314.

249) Means, R.L.: Public Opinion and Planned Changes in Social Behavior: The Ecological Crisis. In: Social Behavior, Natural Resources and the Environment, hrg. von W.R. Burch u.a.. New York 1972, S.203-213.

250) Melber, B.D. u.a.: Nuclear Power and the Public: Analysis of Collected Survey Research. Battelle Memorial Institute. Seattle, Washington. November 1977.

251) Meinefeld, W.: Einstellung und soziales Handeln. Reinbek 1977

252) Metzen, H.: Mensch und Technik aus philosophischer und psychologischer Sicht. In: Technik contra Humanität. Lenggrieser Tage 6.-8.Juli 1979. München 1979.

253) Meyer-Abich, K.M. (Hrg): Energieeinsparung als neue Energiequelle/Wirtschaftspolitische Möglichkeiten und alternative Technologien. Wien 1979.

254) Mez., L. (Hrg): Der Atomkonflikt. Atomindustrie, Atompolitik und Anti-Atombewegung im internationalen Vergleich. Berlin (West) 1979.

255) Mez, L.; Wilke, M. (Hrg): Der Atomfilz. Gewerkschaften und Atomkraft. Berlin 1977.

256) Miller, A.G., Gillen, B., Schenker, C., Radlove, S.: The prediction and perception of obedience to authority. In: Journal of Personality Nr. 42, 1974, S.23-42.

257) Moldenhauer, B.: Politische und ökonomische Entstehungsbedingungen der zivilen Atomindustrie. In: Blätter für deutsche und internationale Politik Nr. 7, 1975, S.741-754.

258) Moncrief, L.M.: The Cultural Basis of our Environmental Crisis. In: Western Man und Environmental Ethics - Attitudes toward Nature and Technology, hrg. von D.G. Barbour. London, Don Mills, Ontario 1973.

259) Morrison, D.E. u.a.: The Environmental Movement. Some Preliminary Observations and Predictions. In: Social Behaviour, Natural Resources and the Environment, hrg. von W. Burch u.a.. New York 1972, S.259-279.

260) Mortimer, R.C.: Moral Aspects of Nuclear Energy. In: Economic and Social Consequences of Nuclear Energy, ed. by Lord Sherfield. Oxford 1972, S.69-75.

261) Müller, A.M.K.: Rechnerische oder wirkliche Sicherheit? Zum Dilemma der Risikoeinschätzung in nuklearen und nuklear induzierten Mensch-Maschine-Systemen. In: Alternative Möglichkeiten für die Energiepolitik, hrg. von W. Lienemann u.a., Band 2. Heidelberg 1977, S.128-158.

262) Müller, P.: Energie - Von der Staumauer zum Kernkraftwerk. Wien, Zürich, München 1978.

263) Müller, S.: Untersuchungen zur Messung pessimistischer und optimistischer Zukunftserwartungen. Köln/Bonn 1973.

264) Müllert, N.R.: Veränderungschancen in der Industriegesellschaft. In: Technologie und Politik, Bd.11, Sanfte Technik, hrg. von F. Duve. Reinbek 1978.

265) Münch, E.; Borsch, P.: Gibt es eine wissenschaftliche Kernenergie-Kontroverse. In: Kernenergie und Öffentlichkeit, hrg. von W.D. Müller und R. Hossner. Düsseldorf 1977, S.28-42.

266) Münch, E.(Hrg.): Tatsachen über Kernenergie. Essen 1980

267) Murphy, A.H.; Winkler, R.L.: Subjective Probability Forecasting: Some Real World Experiments. In: Utility, Probability and Human Decision Making, hrg. von A. Wendt u. C. Vlek. Dordrecht (NL), Boston (USA) 1975, S.177-198.

268) Nader, R.; Abotts, J.: Tödlicher Fortschritt - Atomenergie und ihre Folgen. München 1978.

269) Naßmacher, K.H.: Politikwissenschaft I. Politische Systeme und politische Soziologie. 2. Auflage, Düsseldorf 1973.

270) Narr, W.-D.: Theoriebegriffe und Systemtheorie. Stuttgart/Berlin/Köln/Mainz 1972.

271) Narr, W.-D.: Zur Genesis und Funktion von Krisen - Einige systemanalytische Marginalien. In: Herrschaft und Krise, hrg. von M. Jänicke. Opladen: 1973, S.224-236.

272) National Wildlife Federation: A Study of the Attitudes of the American Public Toward Improvement of the Natural Environment. Report of the National Survey conducted by L. Harris and Associates. Washington, D.C. 1970.

273) Nelkin, D.; Pollak, M.: Consensus and Conflict Resolution. The Politics of Assessing Risk. Vertrag auf der Conference of the European Commission on Technological Risk. Berlin, 1.-3. April 1979.

274) Nelkin, D.: Nuclear Power and its Critics. Ithaca and London 1971.

275) Nelkin, D.: Technological Decisions and Democracy. London, New York 1978.

276) Niehaus, F.: Identification de dêterminants technologiques, psychologiques et sociaux des altitudes viš-å-vis de l'energie nucleaire. In: Colloque sur les implications psycho-sozilogiques du dêveloppment de'l industrie nucleåire. Paris 13-15. Januar 1977, S.454-486.

277) Nisbett, R.E., Borgida, E.: Attribution and the Psychology of Prediction. In: Journal of Personality and Social Psychology, Nr. 32, 1975, S.932-943.

278) Noelle-Neumann, E.: Mehrheit für Kernenergie? In: Atomwirtschaft-Atomtechnik, Beilage: Kernenergie und Umwelt, November 1978, S.III.

279) Noelle-Neumann, E.: Jahrbuch der öffentlichen Meinung 1968-1973. Allensbach. Bonn 1974.

280) Noelle-Neumann, E.: Werden wir alle Proletarier? Wertewandel in unserer Gesellschaft. Osnabrück 1978.

281) Nowotny, H.: Social Aspects of the Nuclear Power Controversy. International Institute for Applied Systems Analysis. RM-76-33. Laxenburg 1976.

282) Nowotny, H.: Kernenergie: Gefahr oder Notwendigkeit. Anatomie eines Konfliktes. Frankfurt/M. 1979.

283) Oberbacher, B.u.a.: Nutzen der Kernenergie - eine ökologisch-ökonomische Betrachtung. Bericht für das Bundesministerium des Innern, hrg. vom Battelle-Institut Frankfurt. Nr.300/2. Frankfurt 1977.

284) Oberbacher, B.u.a.: Vergleich der Gesundheitsgefährdung bei verschiedenen Technologien der Stromerzeugung und erster Versuch der Einordnung des Risikos der Kernenergie. Bericht für das Bundesministerium des Innern, hrg. vom Battelle-Institut Frankfurt. Zwischenbericht 200/1. Frankfurt 1976.

285) Oerter, R.: Struktur und Wandlung von Werthaltungen. München 1972.

286) Offe, C.: Qualität des Lebens - politikwissenschaftliche Aspekte eines politischen Schlagworts. In: Lebensqualität - Von der Hoffung, Mensch zu sein; hrg. von der Landeszentrale für Politische Bildung, NRW. Köln 1974, S.129-136.

287) Offe, C.: Die Logik des kleineren Übels. Ein Vorschlag an die Sozialdemokraten. In: Die Zeit, Heft 46, 9.11.1979.

288) Ohe, von der W. u.a.: Risikoperzeption und Risikoakzeptanz. Zielsetzung, theoretische Annahmen, methodisches Vorgehen und Ergebnisse einiger empirischer Untersuchungen zur Bestimmung der Akzeptanz der Kernenergie durch die Bevölkerung. Auftrag der Gesellschaft für Reaktorsicherheit. Köln 1979.

289) Ohori, H.; Yamada, T.: Public Acceptance of Nuclear Power Development in Japan. IAEA-CN-36/158. Vortrag auf der International Conference on Nuclear Power and Its Fuel Cycle. Salzburg, 2.-13. Mai 1977.

290) Osgood, C.; Tannenbaum, P.H.: The Principle of Congruity in the Prediction of Attitude Change. In: Psychological Review, Vol.52, 1955, Nr.3, S.42-55.

291) Okrent, D.: Risk-Benefit Methodology and Application. Los Angeles 1975

292) Okrent, D.: A General Evaluation Approach to Risk-Benefit for Large Technological Systems and its Application to Nuclear Power. Los Angeles 1977.

293) Otway, H.J.: Risk Estimation and Evaluation. In: Proceedings of the IIASA Planning Conference on Energy Systems. International Institute for Applied Systems Analysis. IIASA-PC-3. Laxenburg, Österreich 1973.

294) Otway, H.J.: Risk Assessment and Societal Choices.International Institute for Applied System Analysis. RM-75-2. Laxenburg 1975.

295) Otway, H.J. u.a.: Social Values in Risk Acceptance. International Institute for Applied Systems Analysis. IIASA RM-75-54. Laxenburg 1975.

296) Otway, H.J. u.a.: Advoidance Response to the Risk Environment. A Cross Cultural Comparison. IIASA RM-75-14. International Institute for Applied Systems Analysis. Laxenburg 1975.

297) Otway, H.J.: A Review of Research on the Identification of Factors Influencing the Social Response to Technological Risks. IAEA-CN-36/4. Vortrag auf der International Conference on Nuclear Power and Its Fuel Cycle. Salzburg, 2.-13.Mai 1977.

298) Otway, H.J.: The Perception of Technological Risks: A Psychological Perspective. Vortrag auf der International Conference of the European Community on Technological Risks. Berlin, 1.-3. April 1979.

299) Otway, H.J., Cohen, J.J.: Revealed Preferences. Comments on the Starr Benefit-Risk Relationship. International Institute for Applied Systems Analysis. IIASA-RM 75-5. Laxenburg 1975.

300) Otway, H.J.; Pahner, P.D., Niehaus, F.: Risk Assessment. In: Second Status Report of the IIASA Project on Energy Systems. International Institute for Applied Systems Analysis. RR-76-1. Laxenburg 1976.

301) Otway, H.J., Pahner, P.D.: Risk Assessment. In: Futures, 8, 1976, S. 122-134.

302) Otway, H.J., Fishbein, M.: The Determinants of Attitude Formation. An Application to Nuclear Power. RM-76-8o. International Institute for Applied Systems Analysis. Laxenburg 1976.

303) Otway, H.J.; Maurer, D.; Thomas, K.: Nuclear Power. The Question of Public Acceptance. In: Futures, April 1978, S.109ff.

304) Pahner, P.D.: The Psychological Displacement of Anxiety. An Application to Nuclear Energy. In: Risk-Benefit Methodology and Application, hrg. von D.Okrent, Los Angeles 1975.

305) Pahner, P.D.: A Psychological Perspective of the Nuclear Energy Controversy. IIASA-Research Memorandum RM-76-67. International Institut for Applied Systems Analysis. Laxenburg 1976.

306) Papp, R. u.a.: A New Concept in Risk Analysis for Nuclear Facilities. In: Nuclear News, 14, 1974, S.62-65.

307) Paschen, H.: Konsequenzen des großtechnischen Einsatzes der Kernenergie in der Bundesrepublik Deutschland. Teil V: Die Akzeptanzproblematik der Kernenergie, bearbeitet von G. Friedrichs und M. Loeben. Kernforschungszentrum Karlsruhe ASA/ZE-14/78. Karlsruhe 1979.

308) Patermann, O.: Das antinukleare Volksbegehren in Kalifornien. Ein neuer Abschnitt der nuklearen Kontroverse in den USA. In: Atomwirtschaft/Atomtechnik. Mai 1976 21, 5, S.237-238.

309) Pearce, D.W.: Decision Making for Energy Futures. London 1979.

310) Pearce, D.W.: The Preconditions for Achieving Consensus in the Context of Technological Risk: Executive Summary. Vortrag auf der Conference of the European Commission on Technological Risk. Berlin, 1.-3. April 1979.

311) Pesch, J.: Staatliche Forschungs- und Entwicklungspolitik im Spannungsfeld zwischen Regierung, Parlament und privaten Experten, untersucht am Beispiel der deutschen Atompolitik. Diss.. Freiburg 1975.

312) Pelicier, Y. u.a.: Exposê des recherches de l'equipe des psycholgie. In: Colloque sur les implications psycho-sociologiques du devêloppement de l industrie nucleaire. Paris 13-15. Januar 1977, S.208-222.

313) Penczynski, P.: Which Energy Strategy is Viable? Invited Paper for the European Nuclear Conference and Foratom VII Congress. Hamburg, 6.-11. Mai 1975.

314) Peters, W.: Befragung in Biblis. Haben Sie Angst vor "Ihrem" Kernkraftwerk. In: Bild der Wissenschaft, Heft 11, Jhrg.16, November 1979, S.96ff.

315) Pickshaus, K.: Das Beispiel Wyhl - Der Kampf gegen den Bau von umweltgefährdenden Kernkraftwerken. In: Marxistische Blätter, Band 3, 1975, S.71ff.

316) Picht, G.: Die Wertordnung einer humanen Umwelt. In: Alternative Möglichkeiten für die Energiepolitik. Materialien zum Gutachten. Band 1, hrg. von W. Lienemann u.a.. Heidelberg 1977.

317) Pochin, E.E.: The Acceptance of Risks. In: Britisch Medical Bulletin, Nr.3, 1975, S.184-190.

318) Pochin, E.E.: Importance relative des differents risques. In: Colloque sur les implications psycho-sociologiques du dêveloppement de l'industrie nucleaire. Paris 13-15. Januar 1977, S.44-55.

319) Popp, M.: The Public Discussion About the Peaceful Utilization of Nuclear Energy in the Federal Republic of Germany and the Information and Discussion Campaign of the Federal Government. IAEA-CN-36/81. Vortrag auf der International Conference on Nuclear Power and Its Fuel Cycle. Salzburg, 2.-13. Mai 1977.

320) Prüß, K.: Kernforschungspolitik in der Bundesrepublik Deutschland. Frankfurt 1974.

321) Albrecht, P. u.a.: Public Acceptance of Nuclear Power - Some Ethical Issues, hrg. von der Energy Advisory Group of the Working Committee on Church and Society. IAEA-CN-36/383. Vortrag auf der International Conference on Nuclear Power and Its Fuel Cycle. Salzburg, 2.-13. Mai 1977.

322) Pyron, B.: Form and Diversity in Human Habitats. Judgemental and Attitude Responses. In: Environment and Behaviour, Nr.3, März 1972, S.87ff.

323) Rammstedt, O.: Krisenverhalten. In: Bürgerbeteiligung und Bürgerinitiativen, hrg. von H. Matthöfer. Argumente in der Energiediskussion, Bd.3. Villingen 1977, S.40-65.

324) Rammstedt, O.: Soziale Bewegung - Modell und Forschungsperspektiven. Ebenda, S.447-475.

325) Rammstedt, O.: Soziale Bewegung. Frankfurt 1972.

326) Rankin, W.L.; Nealey, S.M.: Public Attitudes about Nuclear Waste Management. Battelle Memorial Institute. Human Affairs Research Centre. Seattle 1978.

327) Ravetz, J.R.: Criticisms of Science. In: Science, Technology and Society, hrg. von I.Spiegel-Rösing und D. de Solla Price. London/ Beverly Hills 1972, S.71ff.

328) Ravetz, J.R.: Public Perceptions of Acceptable Risks - As Evidence For Their Cognitive, Technical and Social Structure. Vortrag auf der: Conference of the European Commission on Technological Risk. Berlin, 1.-3. April 1979.

329) Reactor Safety Study: An Assessment of Accident Risks in U.S. Commercial Nuclear Power Plants. WASH-1400, NUREG-74/014. Washington, D.C. Nuclear Regulatory Commission. Washington 1975.

330) Renn, H.: Nichtparametrische Statistik. Studienskripten zur Soziologie, Band 4. Stuttgart 1975.

331) Renn, O.: Kernenergie aus der Sicht der Bevölkerung. KFA-AKI-IB-I/77. Jülich 1977.

332) Renn, O.: Kernenergie und ihre Aufnahme durch die Bevölkerung. In: Energie für morgen - Planung von heute; hrg. von D. Görgmaier. Bayerische Landeszentrale für Politische Bildung, München 1978, S.105ff.

333) Renn, O.: Sozialpsychologische und soziologische Erklärungsversuche zur Risikoakzeptanz. In: Energie, Zeitschrift für praktische Energietechnik, Hefte 6, 7, 8/9 Juni bis September 79, S.161-166, 195-197, 271-274.

334) Rogers, E.M.: The Diffusion of Innovations. New York 1963.

335) Röglin, H.Ch.: Sozialpsychologie der Kernenergie-Kontroverse. Kurzfassung des Vortrages in der Informationszentrale der Elektrizitätswirtschaft e.V. Frankfurt, 29.11.1976.

336) Röglin, H.Ch.: Das aktuelle Interview. "Sind Atomkraftwerke sicherer als Kernkraftwerke?" Umschau in Wissenschaft und Technik, 77, 1977, 2, S.38-40.

337) Röglin, H.Ch.: Sozialpsychologische Aspekte der Kernenergie. In: Kernenergie und Öffentlichkeit, hrg. von W.D. Müller und R. Hossner, Nr.9 der atw-Broschüren "Kernenergie und Umwelt". Düsseldorf 1977, S.1o-27.

338) Röglin, H.Ch.: Kommunikation und Audovision. In:Audiovision, 8. Jahrgang Nr.12, Dezember 1977, S.58-65.

339) Röthlein, B.: Kernenergie - ein Thema der öffentlichen Meinung Dissertation. Universität München. München 1979.

340) Rokeach, M.: The Nature of Attitudes. In: Encyclopedia of the Social Sciences. Band 1, New York 1968, S.449-458.

341) Rokeach, M.: Beliefs, Attitudes and Values. San Francisco 1969

342) Rosenberg, J.J., Hovland, C.J.: Attitude Organization and Change. An Analysis of Consistency Among Attitude Components. New Haven 1960 (S.1-64).

343) Rosenberg, M.J.: Cognitive Structure and Attitudinal Affect. In: Journal of Abnormal and Social Psychology, Nr.53, 1956, S.367-372.

344) Rönsch, H.D.: Reaktionen auf staatliches Handeln am Beispiel des Wahlverhaltens. In: Bürgerbeteiligung und Bürgerinitiativen, hrg. von H. Matthöfer. Villingen 1977, S.344-395.

345) Rosi, E.J.: Mars and Attentive Opinion on Nuclear Weapons Test and Fallout 1954-1963. In: Public Opinion Quarterly, Nr.2 1965, S.280-297.

346) Ross, L.D.: The Intuitive Psychologist and His Shortcomings: Distortions in the Attribution Process. In: Advances in Experimental Social Psychology, hrg. von L. Berkowitz, Vol. 10. New York 1977, S.173-220.

347) Roszak, Th.: Gegenkultur. Gedanken über die technokratische Gesellschaft und die Opposition der Jugend. Düsseldorf, Wien 1971.

348) Roth, W.: Mit den Grünen nicht ins Bett. Warum die Sozialdemokraten die Alternativler am Einzug in den Bundestag hindern wollen? In: Die Zeit, Heft 49, 3o.11.1979.

349) Rowe, W.D.: An Anatomy of Risk. New York, London, Sydney, Toronto 1977

350) Rowe, W.D.: Cost-Effectiveness Determination by Structured Value Analysis. In: WP-Review 1, 1980, Mc Lean, virginia. The MITRE-Corporation, Februar 1969.

351) Rudloff, W.: "Kernenergie und Öffentlichkeit - Nur ein Informationsproblem?" Von der Information zur Kommunikation mit dem Bürger. Referat auf der Jahrestagung der Deutschen Public Relations Gesellschaft, 27. Mai 1976.

352) Sachsse, H.: Anthropologie der Technik. Braunschweig 1978.

353) Sagan, L.A.: The Human Costs of Nuclear Power. In: Science, Vol.177, Nr. 11, August 1972, S.487-493.

354) Sahner, H.: Schließende Statistik. Studienskripte zur Soziologie, Band 2. Stuttgart 1971.

355) Sandstrøm, S.: The Swedish Nuclear Debate. Vortrag auf dem AIF-Workshop: Nuclear Information Strategies: New Settings, New Approaches. Las Vegas, 26-29. September 1976.

356) Santmire, H.P.: Historical Dimension of the American Crisis. In: Western Man and Environmental Ethics, hrg. von J.G. Barbour. London, Don Mills, Ontario 1973.

357) Seetzen, J.: Auf der Suche nach einem neuen Lebensstil. Reaktion auf die Probleme der Großtechnologie. Vortrag auf der RWE-Veranstaltung "Energie- und Umweltfragen". Mainz, 16.-19.4.1978.

358) Seetzen, J.: Entwicklung zu einer allgemeinen Systemtechnik - Die darin enthaltenen Probleme des Menschen. In: Kybernetik und Theologie. Sonderheft der Zeitschrift für Pastoraltheologie, Band 56. Köln 1967, S.160-170.

359) Seitz, W.: Soziale Einstellungen und ihre objekt-spezifische Differenzierung. Dissertation an der Universität Würzburg. Würzburg 1973.

360) Selvidge, J.: A Three-step Procedure for Assigning Probabilities to Rare Events. In: Utility, Subjective Probability and Human Decision Making, hrg. von D. Wendt u. C. Vlek. Dordrecht (NL), Boston (USA) 1975.

361) Shaw, M.E.; Wright, J.M: Scales for the Measurement of Attitudes. New York 1967.

362) Sherfield, L.: The sociological consequences of nuclear energy. In: Economic and Social Consequences of Nuclear Energy, hrg. von L. Sherfield. Oxford 1972.

363) Silbermann, C.E.: The Myth of Automation. London, Evanston, New York 1966.

364) Slovic, P.; Lichtenstein, S.: Relative Importance of Probabilities and Payoffs in Risk-Taking. In: Journal of Experimental Psychology. Vol.78, Nr.3, November 1968, S.1-18.

365) Slovic, P., Kunreuther, H., White, G.F.: Decision processes, rationality, and adjustment to natural hazards. In: Natural hazards. Local, national, global, hrg. von G.F.White. New York 1974, S.187-205.

366) Slovic, P., hhoff, B., Lichtenstein, S.: Cognitive processes and societal risk taking. In: Cognition and Social Behavior, hrg. von J.S.Carroll and J.W. Payne. New York 1976, S.165-184.

367) Slovic, P.;Fischhoff, B., Lichtenstein, S.: Behavioral Decision Theory. In: Annual Review of Psychology. Bd. 28, 1977, S.1-39.

368) Slovic, P., Lichtenstein, S.;Fischhoff, B.: Images of Disaster: Perception and Acceptance of Risks from Nuclear Power. In: Impacts and Risks of Energy Strategies. Their Analysis and Role in Management. Proceedings of the Conference in Stockholm, 26-25. Sept. 1978. In Druck.

369) Slovic, P.: The Psychology of Protective Behavior. In: Journal of Safety Research, Vol.10, Nr. 2, 1978, S.58-68.

370) Slovic, P.;Fischhoff, B.: How safe is safe enough? Determinants of Percieved and Acceptable Risk. In: Too Hot to Handle: Social and Policy Issues in the Management of Radioactive Wastes, hrg. von L. Gould and C.A. Walker. Yale University Press. In Vorbereitung (Manuskript: Januar 1979).

371) Slovic, P.; Lichtenstein S.;Fischhoff, B.: Rating the Risks. In: Environment, Vol. 21, Nr.3, April 1979, S.14ff.

372) Slovic, P.;Fischhoff, B.; Lichtenstein, S.: Perceived Risk. Unveröffentlichtes Vortragsmanuskript. Revised Version vom Dezember 1979. Eugene (Oregon) 1979.

373) Smidt, D.: Die Grenzen von Naturwissenschaft und Technik. In: Atomwirtschaft, Atomtechnik, Jahrgang 25, Bd.2, Februar 1970, S.70-73.

374) Sjøberg, T. u.a.: The Structure of Energy Attitudes and Beliefs. An Interview Study. Stockholm 1978.

375) Spada, H.; Hoffmann, L.; Lucht-Wraage, H.: Student Attitudes Toward Nuclear Power Plants. A Classroom Experiment in the Field of Environmental Psychology. In: Studies in Educational Evaluation. Vol.3, Nr.2, 1977, S.109-128.

376) Spiegel-Rösing, I.: The Study of Science, Technology and Society. Recent Trends and Future Challenges. In: Science, Technology and Society, hrg. von I. Spiegel-Rösing und D. de Solla Price. London/Beverly Hills 1972.

377) Suchman, E.A.: Preventive Health Behavior: A Model for Research on Community Health Campaigns. In: Journal of Health and Social Behaviour Nr.8, 1967, S.197-209.

378) Summers, D.; Ashworth, C.: Types of Conflict in Nuclear Power Plant Disputs. Battelle Research Center. Unveröffentlichtes Manuskript. Seattle (Washington) 1976.

379) Swaton, E. u.a.: The Determinants of Risk Perception: The Active-Passive Dimension. International Institute for Applied Systems Analysis. RM-76-74. Laxenburg 1976.

380) Schäfer, R.E.: What are we talking about when we talk about "risk"? A Critical Survey of Risk and Risk Preference Theories. International Institute for Applied Systems Analysis. RM-78-69. Laxenburg (Österreich) 1978.

381) Schäfer, R.E.; Swaton, E.; Niehaus, F.: Measuring Attitudes Towards the Use of Nuclear Power: An Analysis of a Measuring Instrument. WP-81-XX, International Institute for Applied Systems Analysis. Laxenburg (Österreich) 1981.

382) Scharioth, J.; Krebsbach, C.: Ergebnisse sozialwissenschaftlicher Forschung zur Energiediskussion. Arbeitsunterlage für die Sitzung des Bund/Länder-Arbeitskreises in Bonn, 17. Mai 1977.

383) Scharioth, J.: Die nukleare Kontroverse aus gesellschaftlicher und psychologischer Sicht. In: Atomwirtschaft-Atomtechnik, 22, 1977, S.338-343.

384) Schelsky, H.: Der Mensch in der wissenschaftlichen Zivilisation. Köln/Opladen 1961.

385) Scheuch, E.K.: Auswahlverfahren in der Sozialforschung. In: Handbuch der empirischen Sozialforschung, hrg. von R. König, 3. Auflage. Band 1. Stuttgart 1973.

387) Scheuch, E.K.: Zehnpfennig, H.: Skalierungsverfahren in der Sozialforschung. In: Handbuch der empirischen Sozialforschung, hrg. von R. König. 3. Auflage. Band 3a, Stuttgart 1973, S.97-203.

388) Scheuch, E.K.; Daheim, J.P.: Soziale Schichtung. In: Sonderheft 5 der Kölner Zeitschrift für Soziologie und Sozialpsychologie, hrg. von D.V. Glass und R. König, 4. Auflage. Köln/Opladen 1970.

389) Scheuch, E.K.: Kulturintelligenz als Machtfaktor: Intellektuelle zwischen Geist und Politik. Zürich 1974.

390) Scheuch, E.K.: Bedarf an zukünftiger Energie. Brief an das Bundesministerium für Forschung und Technologie, z.Hd. Herrn Däunert, 14. Januar 1975.

391) Scheuch, E.K.: Bürgerinitiativen: Haben die Parteien versagt? Fernsehinterview in Fragen zur Zeit. ZDF-Sendung vom 27.o3.1977, 13,oo Uhr, Manuskript Nr. 6493/0291.

392) Schild, R.A.: Bombe und Kraftwerk. Ludwigshafen 1974.

393) Schiraski, W.: Möglichkeiten und Grenzen vergleichender Modelluntersuchungen am Beispiel der Umweltbelastung durch Kernkraftwerke. In: Technikfolgen-Technik-Abschätzung, hrg. von H. Haas. München, Wien 1975.

394) Schmidt, H.D. u.a.: Soziale Einstellungen. München 1975

395) Schmidtner, F.X.: Das Kernkraftwerk. In: Energie für morgen - Planung von heute, hrg. von D. Görgmaier, Bayerische Landeszentrale für Politische Bildung. München 1978.

396) Schoeck, H.: Oekospasmus oder die Angst vor Kernkraftwerken. In: Umwelt, Bd.2, 1976, S.125-128.

397) Schoeck, H.: Die Entwicklung des Umweltbewußtseins - Konfliktstoff in einer dynamischen Wirtschaft. In: Datscope 23. 1977, S.4-13.

398) Schrenk, M.: Sachlichkeit - Emotionalität - Identität. In: Kernenergie-Mensch-Umwelt, hrg. von K. Öser u.a.. Köln 1976, S.99ff.

399) Schrenk, M.: Solidarität, Dialog und Dialekt in privaten und öffentlichen Konflikten. In: Unabhängiger Biologischer Nachrichtendienst. Ausgabe 11, 1978, S.7ff.

400) Schüller, .R., Fowler, J.R.: Social Consequences of Power Generation. Research Difficulties and Opportunities. Lecture on the Annual Meeting of the Society for General Systems Research. New York, 27-30 Jan.1975.

401) Schumacher, E.F.: Die Rückkehr zum menschlichen Maß. Hamburg 1977.

402) Schumacher, H.G.: Legitimation und Partizipation von Bürgerinitiativen. Umweltschutz in der Energiediskussion - Möglichkeiten und Grenzen. In: Bürgerbeteiligung und Bürgerinitiativen, hrg. von H. Matthöfer. Villingen 1977,

403) Schuster, G.: Die Kontroverse über die Einführung der Atomenergie. In: Das Leben, Nr.5, 6. Wiesbaden 1971.

404) Schuster, G.: Technological Risk: Perception and Handling in the EEC. Introductory Remarks. International Conference of the European Committee on Technological Risk. Berlin, 1-3. April 1979.

405) Stannard, J.N.: Evaluation of Health Hazards to the Public Associated with Nuclear Power Plant Operations. In: Nuclear Power and the Public, hrg. von H. Foreman. Minneapolis 1970.

406) Starr, Ch.: Social Benefit Versus Technological Risk. In: Science, Vol.165, Nr.169, September 1969, S.1232-1238.

407) Starr, Ch.: Benefit-Cost Relationships to Socio-Technical Systems. In: Environmental Aspects of Nuclear Power Stations. IAEA SM-146/47. International Atomic Energy Agency. Wien 1971, S.900ff.

408) Starr, Ch.: General Philosophy of Risk-Benefit Analysis. Vortrag im Electric Power Research Institute EPRI, Stanford, IES Seminar. Stanford (California), 30. September 1974.

409) Starr, Ch.: Risk and Risk Acceptance by Society. In: Technische Mitteilungen, 70. Jahrgang, Heft 6/7, Juni/Juli 1977. S.444-450.

411) Stazesky, F.M.: The Public Acceptance Issue. Lecture at the Annual Conference, Industrial Forum. San Francisco, 16-2o. November 1975.

412) Steger, U.: Die soziale Verträglichkeit von Energietechnolgien. In: Die neue Gesellschaft, Bd.25, 1978, S.992-993.

413) Steinbuch, K.: Mensch, Technik, Zukunft. Reinbek 1973.

414) Sternstein, W.: Bürgerinitiativen gegen Atomanlagen. Aus der Arbeit eines Aktionsforschers. Frankfurt/Main 1978.

415) Der Störfall von Harrisburg. Offizieller Bericht der von Präsident Carter eingesetzten Kommission über den Reaktorunfall auf Three Mile Island. Düsseldorf 1979.

416) Strümpel, B.: Wirtschaftpolitische Strategien zur Senkung des Energieverbrauchs. In: Energieversorgung und Lebensqualität, hrg. von V. Hauff. Argumente in der Energiediskussion, Bd.6. Villingen 1978, S.155ff.

417) Strümpel, B.: Die Krise des Wohlstandes. Stuttgart 1972.

418) Taviss, I.: A Survey of Popular Attitudes Toward Technology. In: Technology and Culture, Bd.13, 1072, S.606-621.

419) Tenbruck, F.H.: Deutsche Soziologie im internationalen Kontext. Ihre Ideengeschichte und ihr Gesellschaftsbezug. In: Deutsche Soziologie seit 1945. Sonderheft 21 der Kölner Zeitschrift für Soziologie und Sozialpsychologie. Köln 1979, S.71ff.

420) Thomas, K. u.a.: Nuclear Energy: The Accuracy of Policy Makers Perceptions of Public Beliefs. International Institute for Applied Systems Analysis. RM-80-18. Laxenburg (Österreich) 1979.

421) Thomas, K. u.a.: A Comparative Study of Public Beliefs about Five Energy Systems. International Institute for Applied Systems Analysis. RM-80-15. Laxenburg (Österreich) 1979.

422) Tognacci, L.N. u.a.: Environmental Quality: How Universal is Public Concern? In: Environment and Behaviour. Nr.3, März 1972, S.73ff.

423) Touraine, A.: Workers Attitudes to Technical Change. Paris 1965.

424) Tschiedel, R.: Zur Theorie der Orientierung von Wissenschaft. Dissertation an der Philosophischen Fakultät der Westfälischen Wilhelms-Universität Münster. 1977.

425) Traube, K.: Müssen wir umschalten? Von den politischen Grenzen der Technik. Reinbek 1978.

426) Traube, K.: Wachstum oder Askese? Kritik der Industrialisierung von Bedürfnissen. Reinbek (bei Hamburg) 1979.

427) Triandis, H.C.: Toward an Analysis of the Components of Interpersonal Attitudes. In: Attitude, Ego-Involvement and Change. New York 1967, S.227-270.

428) Tubiana, M.: One Approach to the Study of Public Acceptance. In: Directions in Energy Policy. A Comprehensive Approach to Energy Resource Decision-Making, hrg. von B. Kursunoglu und A. Perlmutter, 1980, S.343-356.

429) Turner, R.H.: The Public Perception of Protest. American Sociological Review 1969, 35, S.815-831.

430) Tversky, A., Kahneman, D.: The belief in the "law of small numbers". In: Psychological Bulletin Nr.76, 1971, S.105-110.

431) Tversky, A., Kahneman, D.: Availability: A heuristic for judging frequency and probability. In: Cognitive Psychology Nr.4, 1973, S.207-232.

432) Tversky, A., Kahneman, D.: Judgement under Uncertainty. Heuristics and Biases. In: Utility, Probability and Human Decision Making, hrg. von D. Wendt und C. Vlek. Dordrecht (Holland), Boston (USA) 1975, S.141-162.

433) Tversky, A.: Kahneman, D.: Judgement under Uncertainty: Heuristics and Biases. In: Science, Band 185, 1974, S.1124-1131.

434) Ullrich, Otto: Technik und Herrschaft. Frankfurt/Main 1977.

435) Unruh, G.C. von: Wie verhält sich die Bürgerinitiative zur Repräsentation. In: Kontrovers-Bürgerinitiativen, hrg. von der Bundeszentrale für politische Bildung NRW, bearbeitet von U. Kempf. Bonn 1974, S.74.

436) Verba, S.; Nie, N.H.: Participation in American Political Democracy and Social Equality. New York 1972.

437) Das Veto, Der Atombericht der Ford-Foundation (Original von Keeny und Spurgeon als Herausgeber). Frankfurt 1977.

438) Vilmar, F.: Elemente einer integralen Theorie der Partizpation. In: Bürgerbeteiligung und Bürgerinitiative, hrg. von H.Matthöfer. Argumente in der Energiediskussion, Bd. 3, Villingen 1977, S.294-315.

439) Vilmar, F.: Strategien der Demokratisierung. Neuwied 1973.

340) Vinck, W.: Practices and Rules for Nuclear Power Stations; The Role of the Risk Concept in Assessing Acceptability. Vortrag auf der International Conference of the European Committee on Technological Risk. Berlin, 1-3. April 1979.

441) von Erichsen, L.: Friedliche Nutzung der Kernenergie. Ihre Vorteile und Gefahren. Berlin, Göttingen, Heidelberg 1962.

442) Vroom, V.H.: Work and Motivation. New York 1964.

443) Wagner, H.J.: Risikoanalyse ausgewählter Energieversorgungstechnologien. Interner Bericht KFA-STE-IB 2/78. Kernforschungsanlage Jülich. Jülich 1978.

444) Weinberg, A.M.: Science and Trans-Science. In: Minerva, Vol.10, London 1972, S.1342ff.

445) Weinberg, A.M: Social Institutions and Nuclear Energy. In: Science, Vol. 179, Nr.4043, 7. Juli 1972, S.27-34.

446) Weingart, P.: Das "Harrisburg-Syndrom" oder die De-Professionalisierung der Experten. In: Kernenergie: Gefahr oder Notwendigkeit, von H. Nowotny. Frankfurt/M. 1979, S.9-17.

447) Weizsäcker, C.F. von: Wege in der Gefahr. Eine Studie über Wirtschaft, Gesellschaft und Kriegsverhütung. München 1976.

448) Weizsäcker, C.F. von: Eine Schlacht der Moral. Plädoyer für ein besseres Verständnis beim Pro und Contra um die Kernenergie. In: Die Zeit, 15.o6.1979.

449) Whitney, H.: Some Sociological Consequences of Atomic Power. Annals of the American Academy of Political and Social Science. Philadelphia 1953.

450) WHO-Report: Mensch und Atom - Bericht einer Studiengruppe der Weltgesundheitsorganisation. WHO-Report Nr. 13. München 1960.

451) Wicker, A.W.: Attitude versus Actions: The Relationship of Verbal and Overt Behavioral Responses to Attitude Objects. In: Journal of Social Issues, Band 25, 1969, S.41-78.

452) Wiehn, E.R.: Industrielle Bedürfnisse und soziale Werte. Tübingen 1972.

453) Wiehn, E.R.: Theorien der sozialen Schichtung. In: Studien der Soziologie, hrg. von R. Dahrendorf, Band 9. München 1969.

454) Wiesner, L.: Minimierung der Summe aller Risiken. In: Atomwirtschaft-Atomtechnik, Band 3, 1979, S.145-150.

455) Willi, V.J.: Grundlagen einer empirischen Soziologie der Werte und Wertsysteme. Zürich 1966.

456) Wilkinson, P.: Soziale Bewegungen. München 1974.

457) Wirtz, Karl: Die Errichtung großer Kernkraftwerke in oder in der Nähe von Bevölkerungszentren. Gutachten im Auftrag des Hessischen Ministeriums für Wirtschaft und Verkehr. Karlsruhe 1968.

458) Wiswede, G.: Rationalität und soziales Wertesystem. In: Zeitschrift für Wirtschafts- und Sozialwissenschaften, Nr.2, 1972.

459) Wiswede, G.; Kutsch, Th.: Sozialer Wandel. Zur Erklärungskraft neuerer Entwicklungs- und Modernisierungstheorien. Darmstadt 1978.

460) Wünschmann, A.: Unbewußt dagegen - Zur Psychologie der Kernenergiekontroverse. Bonn aktuell. Stuttgart 1980.

461) Wüstenhagen, H.-H.: Bürger gegen Kernkraftwerke, Whyl - der Anfang? Reinbek 1975.

462) Wüstenhagen, H.-H.: Bürgerinitiativen, Atomenergie und Wissenschaft. In: Sozialisierung der Verluste, hrg. von K.W. Kapp und F. Vilmar. München 1972, S.8ff.

463) Wyer, R.S.: An Investigation of the Relations Among Probability Estimates. In: Organizational Behavior and Human Performance, Nummer 15, 1976, S.1-18.

461) Wyer, R.S.: The Prediction of Evaluations of Social Role Occupants as a Function of the Favourableness, Relevance and Probability with Attributes of these Occupants. In: Sociometry, Nr. 33, 1970, S.79-96.

465) Zangger, C.: Interaction entre controle et acceptation de l'energie nucleaire en Suisse-objectifs et mise en oeuvre. IAEA-CN-36/579. Vortrag auf der International Conference on Nuclear Energy and Its Fuel Cycle. Salzburg, 2.-13. Mai 1977.

466) Zajonc, R.B.: Cognitive Theories in Social Psychology. In: The Handbook of Social Psychology, hrg. von G. Lindzey und E. Aronson. Reading (Mass.) 1968.

467) Zebroski, E.L.: Attainment of Balance in Risk-Benefit-Perceptions. In: Risk-Benefit-Methodology and Application. Engineering Foundation Workshop. Asilomar (Californien), Report ENG-7598, Dezember 1975, S.633-644.

468) Zeckhauser, R.: Risk Spreading and Distribution. In: The Political Economy of Income Distribution, hrg. von H. Hochmann und W.E. Peterson, New York 1973, S.206-228.

469) Zehnder, R.: Historical Background of Societal Resistance to Technology. Research-Memorandum des International Institue for Applied Systems Analysis, Vorabdruck vom 28.12.1977. Laxenburg 1977.

470) Zetterberg, H.: Environmental Awareness and Political Change in Sweden. Vortragsmanuskript zur Konferenz on Environmental Awareness and Politcal Change. Wissenschaftszentrum Berlin, 1978.

471) Zilleßen, H.: Bürgerinitiativen im repräsentativen Regierungssystem. Aus Politik und Zeitgeschehen. Beilage der Wochenzeitung "Das Parlament" Nr. 12, 23.o3.1974.

472) Zilleßen, H.: Energiepolitik - Dialog mit dem Bürger? In: Aus Politik und Zeitgeschichte. Beilage zur Wochenzeitung: Das Parlament Nr. B, 27, S.12-19.

473) Zilleßen, H.: Energiepolitik und Bürgerinitiative. In: Kernenergie-Mensch-Umwelt, hrg. von K. Oeser u.a., Köln 1976.

474) Zilleßen, H.: Bürgerinitiativen und repräsentative Demokratie. In: Bürgerinitiativen und repräsentatives System, hrg. von B. Guggenberger und U. Kempf. Opladen 1978, S.112-132.

475) Zimmermann, E.: Das Experiment in den Sozialwissenschaften. Studienskripten zur Soziologie. Stuttgart 1972.

476) Zischka, A.: Kampf ums Überleben. Das Menschenrecht auf Energie. Düsseldorf/Wien 1979.

477) Zur friedlichen Nutzung der Kernenergie. Eine Dokumentation der Bundesregierung. 2. Auflage, hrg. vom Bundesminister für Forschung und Technologie. Bonn 1978.

Ergänzung zur Literaturliste

478) Abplanalp, P.A.; Hettlage, R.: Wirtschaftspolitik und Kommunikative Umwelt in der "Neuen Politischen Ökonomie " - Einige soziologische Bedenken. In: Jahrbuch für Sozialwissenschaft, Bd 3 , 1979. S.293 bis 311

479) Barrados, M. : Impact on Public Opinion of the Three Mile Accident. Vortrag auf der ENC-FOR-ATOM VII Conference. Hamburg 6.-11. Mai 1979.

480) Bettman, J.R. : Perceived Risk and Its Components: A Model and Empirical Test. In: Journal of Marketing Research, Nr.10, 1973, S.184 bis 190

481) Black, S.; Niehaus, F.; Simpson, D.: How safe is "too" safe? Report WP-79-68, International Institute for Applied Systems Analysis. Laxenburg (Österreich) 1979

482) Bledjian, F.; Stosberg, Ch.: Analyse der Massenkommunikation: Wirkungen. Düsseldorf 1972

483) Cohen, J.; Hansel, M.: Glück und Risiko. Die Lehre von der subjektiven Wahrscheinlichkeit. Frankfurt 1961

484) Coombs, C.H.; Pruitt, D.G.: Components of Risk in Decision Making: Probability and Variance Preferences. In: Journal of Experimental Psychology, Nr. 60 , 1960. S. 265 - 277

485) Coombs, C.H.; Bowen, J.N.: A Test of EV-Theories of Risk and the Effect of the Central Limit Theorem. In: Acta Psychologica, Nr.35, 1971, S.15-28

486) Cunningham, S.M. : The Major Dimensions of Perceived Risk. In: Risk Taking and Information Handling in Consumer Behavior, hrg. von D.F.Cox. Boston 1967, S.82-108

487) Domar, E.; Musgrave, R.A.: Proportional Income Taxation and Risk-Taking. In: Quarterly Journal of Economics, Nr. 58, 1944. S. 388-422

488) Droege, F.; Weisenborn, F.; Haft, R.: Wirkungen der Massenkommunikation. 2. Auflage, Frankfurt/Main 1973

489) Edwards, W. : Variance Preferences in Gambling. In: American Journal of Psychology, Nr.67, 1954, S.441 - 452

490) Jugend in Europa - Ihre Eingliederung in die Welt der Erwachsenen, hrg. vom Jugendwerk der Deutschen Shell. Bände I bis III Bearbeiter: Viggo Graf Blücher. Ohne Ortsangabe 1977

491) Etzioni,A : Mixed Scanning. A Third Approach to Decision Making. In: Public Administration Review, Nr.27, 1967. S. 385-392

492) Frey, B.S. : Eine Theorie demokratischer Wirtschaftspolitik. In: Kyklos, Nr.31, 1978. S. 208-234

493) Goude, G. : Man- A Biological Being or a Technical Mistake? A need to decide how to make decisions. Report of the Project: Risk Generation and Risk Assessment in a Social Perspective. Nr.4, 1977. Stockholm 1977

494) Hammond, K.R.u.a.: Social Judgement Theory. In: Human Judgement and Decision Processes: Formal and Mathematical Approaches, hrg. von M.Kaplan und S.Schwartz. New York 1975

495) Henrich,H. : Störfälle an Kernkraftwerken. In: Kernfragen,hrg. von der Kernforschungsanlage Jülich. Redaktion: S. Weinhold u.a.Jülich 1978.S.16 bis 18

496) Himmelmann,G. : Politische Ökonomie - Herkunft,Probleme, Ansätze : Eine Übersicht. In: Politische Vierteljahresschrift, Bd.18, 1977. S.178-213

497) Hofstätter, P.R.; Wendt,D.: Quantitative Methoden der Psychologie. München 1966

498) Huang, L.C. Subjective Expected Utility, Subjective Expected Risk, and Portfolio Theory. Michigan Mathematical Psychology Program, MMPP-74-9, University of Michigan 1974

499) Janis, J.L.; Mann, L.: Decision Making. A Psychological Analysis of Conflict, Choice and Commitment. New York 1977

500) Kaplan, L.B., Szybillo, G.J.; Jacoby, J.: Components of Perceived Risk in Product Purchase: A Cross-Validation. In: Journal of Applied Psychology, Nr. 59, 1974. S. 287 - 291

501) Katz E.; Levin, M.L.; Hamilton, H.: Traditions of Research on the Diffusion of Innovation. In: American Sociological Review, Nr. 28, 1963. S. 237 - 252

502) Kleining, G. ; Moore, H.: Soziale Selbsteinstufung (SSE). Ein Instrument zur Messung sozialer Schichten. In: Kölner Zeitschrift für Soziologie und Sozialpsychologie, Bd. 20, 1968

503) Kogan, N.; Wallach, M.A.: Risk Taking. Chicago 1964

504) Kogan, N.; Wallach, M.A.: Risk Taking. In: Behavioral Science Foundation of Consumer Behavior, hrg. von J.B. Cohen. New York 1972. S.133-140.

505) Kozielecki, J. : Environment and Personalitiy Determinants in Decision-Making. Polish Psychological Bulletin, Nr. 5, 1974. S. 3 - 11

506) Kriz, J. : Öffentliche Meinung und politisches Handeln - Kritik der "Schweigespirale". In: Bürgerbeteiligung und Bürgerinitiativen, hrg. von H. Matthöfer. Villingen 1977. S. 396 - 416

507) Krelle, W. : Präferenz und Entscheidungstheorie. Tübingen 1968

508) Lakoff, S.A. : Scientists, Technologists and Political Power. In: Science, Technology and Society, hrg. von I. Spiegel-Rösing and D. de Solla Price. London, Beverly Hills 1972. S.355-391.

509) Lee, W. : Decision Theory and Human Behavior. New York 1971

510) Lichtenstein, S. u.a. : Judged Frequency of Lethal Events. In: Journal of Experimental Psychology: Human Learning and Memory, Nr. 4, 1978. S. 551 - 578

511) Lindbloom, C.E. : The Science of Muddling Through. In: Public Administration Review, Nr. 19, 1959. S. 79 - 99

512) Lohmöller, J.-B. : Die trimodale Faktorenanalyse von Tucker: Skalierung, Rotationen, andere Modelle. In: Arch. Psychol. Vol 131, Nr. 2, 1979. S. 137 - 166

513) Markowitz, H. : Portfolio Selection. New York 1959

514) Miller, D.W.; Starr, M.K. : The Structure of Human Decisions. Englewood Cliffs, New Jersey, 1967

515) Payne, I.W. : Relation of Perceived Risk to Preferences among Gambles. In: Journal of Experimental Psychology (Human Perception and Performance), Nr. 104, 1975. S. 86 - 94

516) Pollatsek, A.; Tversky, A.: A Theory of Risk. In: Journal of Mathematical Psychology. Nr. 7, 1970. S. 540 - 553

517) Renn : Auswertung einer Befragung von Lehrern und Juristen zum Thema Kernenergie während eines Besuchs von Fortbildungsseminaren in der Kernforschungsanlage Jülich. Interner Bericht. KFA-KUU-IB-1/78. Kernforschungsanlage Jülich 1978.

518) Rosenstiel, L. von; Ewald, G.: Marktpsychologie Band I: Konsumverhalten und Kaufentscheidung. Stuttgart u.a. 1979.

519) Rothschild, L. Risk. In: Atom, Nr.268, Februar 1979. S.30-35.

520) Savage, L.J. : The Foundation of Statistics. New York 1954.

521) Simon, H. : Administrative Behavior: A Study of Decision-Making-Processes in Administrative Organisations. Third Edition. New York 1976.

522) Sjøberg, L. : Strenght of Belief and Risk. Report of the Project: Risk Generation and Risk Assessment in a Social Perspective. Göteborg (Schweden) 1977.

523) Stallen, P.J.M. : Science of Risk and Risk of Science - with Special Preference to Nuclear Power. In: Utility, Probability and Human Decision Making, hrg. von A. Wendt u. C. Vlek. Dordrecht (NL), Boston (USA) 1975.

524) Stoner, A. : A Comparison of Individual and Group Decisions Involving Risk. Massachusetts Institute of Technology. Boston 1961.

525) Sevenson, O. : A Unifying Interpretation of Different Models for the Integration of Information when Evaluating Gambles. In: Scandinavian Journal of Psychology, Nr.16, 1975. S.187-192.

526) Schweiger, G.; Mazanec, J.; Wiegele, O.: Das Modell des "erlebten Risikos" (-perceived risk-). Struktur und Operationalisierungskonzepte. In: Der Markt, Nr.60, 1976, S.93-102.

527) Tversky, A. : Elimination by Aspects: A Theory of Choice. In: Psychological Review, Nr.79, 1972. S.281-299.

528) Tucker, L.R. : Some Mathematical Notes on Three-Mode-Factor Analysis. In: Psychometrica, Nr.31, 1966, S.279-311.

529) Vlek, Ch.; Stallen, P.J.: Rational and Personal Aspects of Risk. Invited Paper of the 7th Research Conference on Subjective Probability, Utility, and Decision Making. Göteborg 27.-31.August 1979.530) Wilde, G.J.S.

530) Wilde, G.J.S. : Theorie der Risikokompensation der Unfallverursachung und praktische Folgerungen für die Unfallverhütung. In: Hilfe zur Unfallkunde, Nr. 130, 1978, S.134-156.

531) Zuckermann, M. : Sensation Seeking and Anxiety - Traits and States, as Determinants of Behavior in Novel Situations. In: Stress and Anxiety, ed. by I.G. Sarason and C.D. Spielberger, Vol. III. Washington D.C. 1976

532) Kitschelt, H. : Kernenergiepolitik - Arena eines gesellschaftlichen Konflikts. Frankfurt/New York 1980