PERCEPTION AND EVALUATION OF RISKS: *Findings for New Zealand and Cross-Cultural Comparisons*

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ABSTRACT

In a socio-psychological field study, perceptions and subjective evaluations of risky activities and environmental conditions were investigated in three countries: Germany, New Zealand and Australia. The aim of this cross-cultural project is to analyse the cognitive structure of judgments about the magnitude and acceptability of risks to which individuals are exposed, and to compare risk judgments across countries in which risk issues in general as well as particular risk sources (eg, industrial facilities or natural hazards) have different salience.

Data comparisons for countries, for societal groups (eg, ecologists, engineers, feminists) and for types of risks demonstrate manifold differences. However, the considerable influence of psychological aspects on judging risks can be shown in all settings.

Altogether the findings confirm the significance of the cultural context of risk evaluations. They are relevant for a better understanding of conflicts about risk and for improving risk communication among the various involved parties.

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1 PROBLEM

1.1 Risk as an Issue of Social Scientific Research

Over the last decade, "risk" has become a prominent issue of political/societal discourse as well as of social-scientific research. At work or in their private lives humans seem to be exposed to different, to more, and to greater risks than in earlier times (eg, car accidents, smoking, drugs, AIDS, nuclear energy, climatic changes), and the assessment of these risks has become very complex. Some disasters, such as the accidents in Bophal or Chernobyl, the earthquakes in San Francisco or Armenia, or the recent oil catastrophe in Kuwait, have further increased the awareness of risks.

Risk is also a controversial issue. In many societies, severe conflicts about the evaluation of risks have emerged, particularly with respect to large-scale technologies such as chemical industries, nuclear energy and genetic engineering (Beck, 1992; Johnson & Covello, 1987; Jungermann & Slovic, 1993; Jungermann *et al.*, 1991; Luhmann, 1990; Sjoeberg, 1987; Waterstone, 1991). Deep concern about environmental impacts of human activities plays an important role to this situation.

Furthermore, there is a considerable gap between how experts think about risks and how non-professional people judge and evaluate risks. Depending on the underlying definitions and criteria, very heterogeneous risk assessments are given by different groups (Edwards & von Winterfeldt, 1987; Fischhoff *et al.*, 1981; Lichtenstein *et al.*, 1978; Slovic *et al.*, 1985; von Winterfeldt *et al.*, 1981; Renn, 1992). Many of the risks most prominent in the view of the public are not those which - according to statistical data - have the highest accident figures, mortality rates, health impacts, and so on. Apparently many more aspects influence risk perception, risk behaviour and risk management, including a variety of social, psychological and ethical aspects.

Thus political decision-making about risk issues became more and more complicated. Under these conditions it seemed necessary to complement 'technical' risk research (as done in natural sciences or economics) by social-scientific approaches in order to expand the risk concept and to understand the "psychology of risk".

1.2 The Psychometric Approach

Within this context, psychologists have dealt with the meaning of risk, the subjective understanding and evaluation of risk sources and the determinants of risk acceptance (see, eg, Brehmer, 1987; Guerin, 1991; Jungermann & Slovic, 1992; Slovic, 1992; Vlek & Stallen, 1980; Yates & Stone, 1992). Risk perception has been intensively studied, using predominantly psychometric methods. The so-called *psychometric approach* is based on four intentions:

- To establish "risk" as a subjective, rather than an objective concept;
- To include technical/physical *and* social/psychological aspects as risk criteria;
- To accept opinions of "the public" (ie, laypeople, not experts) as the matter of interest;
- To analyse the cognitive structure of risk judgments, using multivariate statistical procedures such as factor analysis, multi-dimensional scaling or multiple regression.

This line of research was originated by B Fischhoff, S Lichtenstein and P Slovic (see Fischhoff *et al.*, 1978; Lichtenstein *et al.*, 1978; Slovic *et al.*, 1980). Quite a number of studies followed, mainly in the USA, Germany and the Netherlands (eg, von Winterfeldt *et al.*, 1981; Vlek & Stallen, 1981; Johnson & Tversky, 1984; Tiemann & Tiemann, 1985; Borcherding *et al.*, 1986; Gould *et al.*, 1988; Lappe *et al.*, 1990; Burgemeister & Weber, 1992).

1.3 Cross-Cultural Risk Perception Studies

Risk research is (still) mainly characterised by an international (or 'non-cultural') perspective. However, the technical or natural disasters mentioned above made it obvious how diverse both the public and the government react to those risks in different countries. Thus some social scientists have also dealt with cross-cultural comparisons. Cultural differences can be studied from two perspectives. In *cross-national* studies, data from different nations (eg, Germany versus USA) or types of countries (eg, industrialised vs developing ones) are compared. In *intra-national* comparisons, differences in risk evaluation between societal groups (defined according to social/political perspectives or membership in interest groups etc) are analysed.

Empirical comparisons of risk perception across nations have been reported for USA vs Germany (von Winterfeldt *et al.*, 1981; Borcherding & von Winterfeldt, 1983), Hungary vs USA (Englander *et al.*, 1986), Norway vs USA (Teigen *et al.*, 1988), France vs USA (Höfer & Raju, 1989), Hong Kong vs USA (Keown, 1989), Russia vs USA (Mechitov & Rebrik, 1990), Poland vs USA (Goszczynska *et al.*, 1991), and USA vs Japan (Kleinhesselink & Rosa, 1991; Hinman *et al.*, 1993). See Table 1 for an overview (this table also includes the present study).

Usually a sample of risks was presented to the respondents and rated according to a set of risk aspects. Other cross-national studies have dealt with one risk source only (eg, Eiser *et al.*, 1990 or Swaton & Renn, 1984). For a documentation and review of risk perception studies see Rohrmann (1991), for a framework of cross-cultural risk research see McDaniels & Gregory (1991).

Most of these comparisons were not planned as synchronous studies but resulted from full or partial replications of earlier work (using research such as the 'path-leading' studies of Fischhoff *et al.* as reference). The samples are rather small and usually not representative of the population. Nevertheless the results indicate considerable cross-cultural differences.

Table 1: Cross-cultural risk perception studies

STUDY	Countries	Sample Size(s)	Subgroups	Risk Sources	Risk Aspects
WINTERFELDT et et al. 1984	USA+Germany	57+68	-	14	4
ENGLANDER et al. '86	Hungary (USA)	30/29 (175)	-	90/30	1/9
TEIGEN et al. '88	Norway (USA)	37/35/64 (175)	-	30/90/35	9/1/9
HOEFER/RAJU '89	France/USA	50+26	-	6	10/1
KEOWN '89	HongKong (USA)	65 (175)	-	30/15	2/6
MECHITOV/REBRIK '90	Russia (USA)	24/24 (175)	2	13/9/75	4/7/1
KLEINHESSELINK/ROSA '91	USA/Japan	62+69	-	70	7
HINMAN et al. '93	Japan/USA	290/747	-	30	4
GOSZCZYNSKA et al. '91	Poland (USA)	140	4	40	1/15
ROHRMANN '89/93 + BORCHERD. & R.'86	Germany+NZ+ Australia	217+278+263	4/8	24	11

Notes:
"(USA)" refers to American data published by Fischhoff et al. 78.
"#/#" indicates sub-samples within a study. - Except for the last two studies, all respondents were students.

1.4 Objectives

The project "Cross-cultural Comparison of Risk Evaluations (CRE)" was started in Germany by K Borcherding and B Rohrmann, and then continued by the present author in New Zealand and Australia. The objectives of the investigation are:

- To analyse the cognitive structure of judgments about the magnitude and the acceptability of risks to which individuals are exposed;
- To specify the relevance of risk characteristics and of societal orientations for subjective risk evaluations; and
- To compare risk judgments across countries in which particular risk sources (related both to individual activities and to environmental/residential conditions) have different salience.

The final goal is achieving a better understanding of conflicts about risks and to gain findings which are useful for improving risk communication between the various parties involved.

The purpose of the present paper is to analyse risk perception based on the data collected in New Zealand and to compare the results with findings from homologous samples surveyed in Germany.

In the first section, the theoretical background and the methodological approach of this study will be described, followed by a description of the data collection in three countries. In Part 3, selected results on mean ratings and correlational analyses (including structural models) will be presented and compared across countries and societal subgroups. Finally, conclusions about the significance of risk perception research and its potential for applied objectives (such as risk communication) will be discussed.

2 RESEARCH APPROACH

2.1 Conceptual Framework

The study is based on a theoretical framework developed in Borcherding *et al.* (1986). In a first step, relevant concepts for the subjective evaluation of risky activities and residential conditions were selected; in step 2, structural relations between the variables representing the respective cognitions have been hypothesised. This framework is shown in Figure 1.

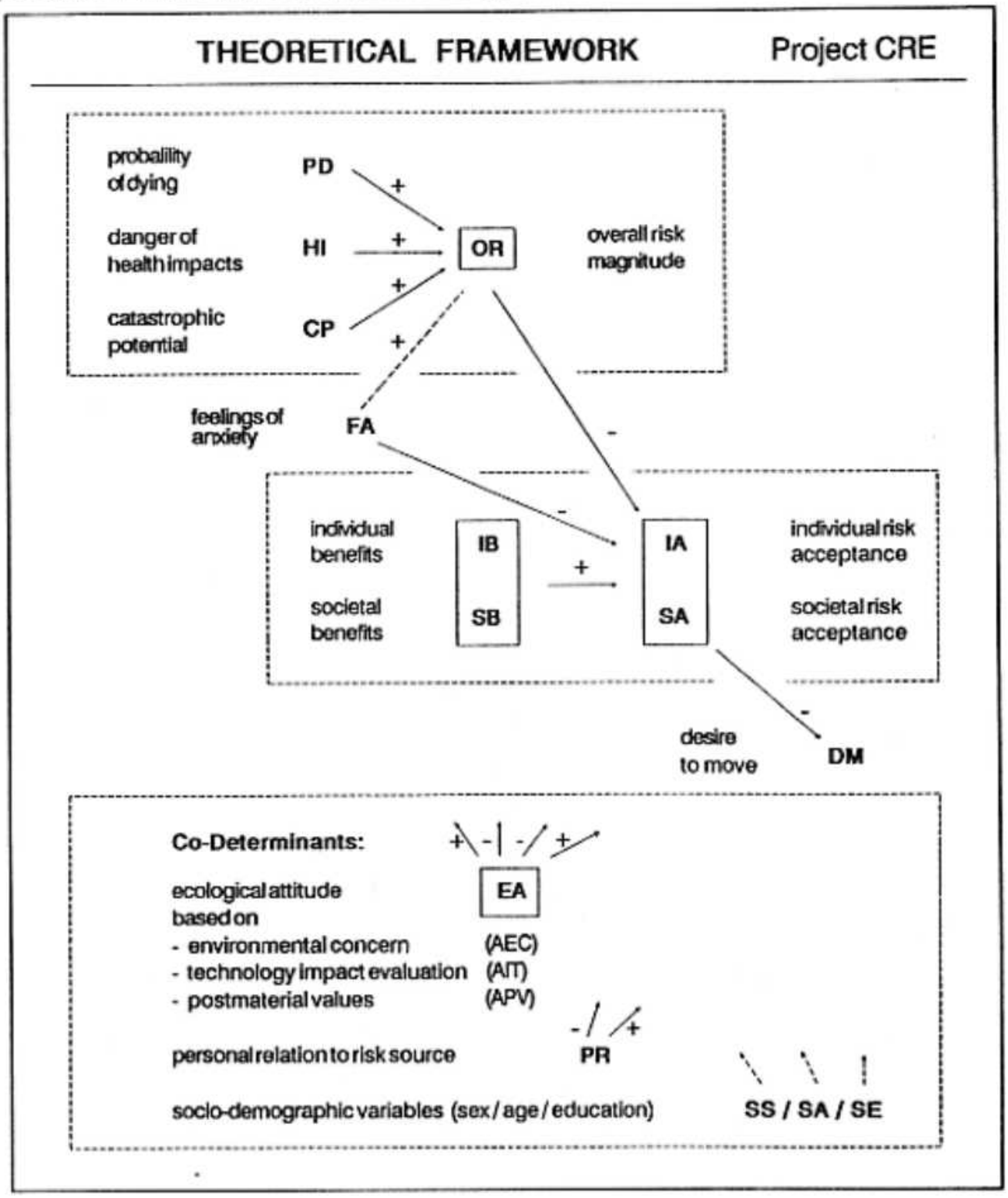

Figure 1: Framework for variables and their structural relations

The two key aspects of evaluating risks are risk magnitude and acceptance of risk. It is assumed that these variables are influenced by other characteristics of the considered risk sources, negative impacts on the one hand and benefits on the other hand, and that ecological attitudes as well as social characteristics are relevant co-determinants. For both risk acceptance and benefits of risky enterprises a distinction is made between the individual perspective and the societal viewpoint.

2.2 Data Collection: Risk Sources, Judgements, Respondents

The general approach of the study is to measure relevant risk evaluation criteria (ie, risk aspects) with respect to a heterogeneous set of risk sources and to collect such data for a variety of societal groups. Each of the three principal aspects of the 'problem space' (ie, aspects, sources, respondents) were treated according to a specific sub-structure.

Previous research on risk perception (cf 1.2) indicates that the hazard type has a strong influence on risk judgments. Thus the selection of *risk sources* to be investigated in this study was based on a taxonomy distinguishing four aspects:

(1) Activities vs residential/environmental conditions;
(2) Acute vs chronic hazards;
(3) *For activities:* occupational vs private;
(4) *For residential* conditions: natural vs technology-induced hazards.

The resulting classification is shown in Table 2.

It should be noted that for each risk source the relation to humans was specified, eg, "working as ..." or "living near ..." while general terms (such as "cars", "asbestos", "nuclear power", "climate") were avoided.

Table 2: Classification of risk sources (Project CRE)

Activities		
A	Parachuting as a sport	acute/private
B	Driving in car races	
C	Down-hill ski training	
K	Working as a fire fighter	acute/occupat.
L	Working as a blaster in quarries	
M	Flying an emergency service helicopter	
G	Long-term heavy smoking	chronic/private
H	Regularly taking tranquilizers	
I	Eating too much and very fatty food	
D	Working in asbestos production	chronic/occup.
E	Working in an X-ray laboratory	
F	Frequent working with air compressor tools	
Residential conditions		
Q	Living in an avalanche-prone area	acute/natural
R	Living in an earthquake-prone area	
S	Living in an area w. many electric storms	
T	Living near an explosives factory	acute/techn.
U	Living near a nuclear power plant	
V	Living near a petrochemical industry	
W	Living in a polluted dense urban area	chronic/natural
X	Living in an area w. unhealthy climate	
Y	Living in an area w. natural radioactivity	
N	Living near a coal power plant	chronic/techn.
O	Living near a smelter/metal prod. factory	
P	Living near a large airport	

All of these risk sources were judged with respect to the *risk aspects* defined in the conceptual framework (cf Figure 1). Furthermore, characteristics of the respondents had to be measured. For this purpose, a standardised instrument (the Risk Evaluation Questionnaire) was constructed. It consists of three parts:

(1) Judgments of 24 risks according to 11 evaluative criteria;
(2) Attitude scales; and
(3) Questions about demographic variables.

Three attitudes were measured: environmental concern (AEC), evaluation of technology impacts (AIT) and societal value orientation (ASV) (economic vs "post-material" values - Inglehart, 1977). The items were taken from studies in environmental psychology (Fietkau *et al.*, 1980; Maloney *et al.*, 1985; Prester *et al.*, 1987).

Risk ratings were done on response scales ranging from 0 to 10, with 10 denoting the highest level of the criterion. The list of variables (altogether about 270 items) is identical for all groups of respondents.

Regarding *respondents*, the study is based on a contrast group design in order to compare groups with specific societal, professional, and cultural orientations (in Douglas & Wildavsky (1982) or Wildavsky & Dake (1990) the term "worldview" is used). It is obvious from the political debates about risks, particularly those related to large-scale technologies (cf 1.1), that the professional socialisation of the proponents leads to distinct evaluations of risk issues. In the sampling plan, three factors were considered:

- Central values: respondents with predominantly 'technological' or 'ecological' orientations were studied (later respondents involved in "feminists' issues" were added as third and those working in "monetarian" professions as fourth group);
- Professional status: employed people and students were differentiated; and
- Nation: the countries included so far are all industrialised 'western' ones but differ in population and size, in the significance of nature and in the political relevance of risk issues.

It should be noted, however, that representative samples of these groups were neither possible (due to limited resources) nor even intended (certainly it is not claimed to compare "New Zealanders" with "Germans" or "Australians" at whole). The idea is rather to use such societal distinctions in order to elucidate typical intra-cultural and cross-cultural differences in risk evaluation.

So far, three sub-studies have been conducted, the basic one in Germany (abbreviated by <D>; see 2.4), the second - substantially enlarged - in New Zealand = NZ (cf 2.3) and a third one in Australia = AUS (cf 2.5). As a further extension, an additional German data deck has been collected to match the NZ set-up. The samples are summarised in Table 3.

Table 3: Project CRE: Groups of respondents - Overview

	D	NZ	AUS	D/new
"Technological orientation" <T>	40	65	*56*	
Engineers	20	34	28*	
Students of technical sciences	20	31	28*	
"Ecological orientation" <E>	40	92	*73*	
Environmentalists	20	26	32*	
Geography/Psychology students	20	66	41*	
"Feministic orientation" <F>		67	*72*	*60*
Members of feministic groups		47	40*	30*
Students of women's studies		20	32*	30*
"Monetarian orientation <M>		54	*62*	*77*
Accountants/finance managers		26	33*	36*
Students in economics/finance		28	29*	41*
N =	80	278	*263*	*137*

* *For these samples, data analyses and comparisons with results from the previous data collection are under way.*

2.3 The Initial German Study

The first study was conducted in Mannheim and Darmstadt and is shortly described in Borcherding *et al.*, (1986) and Rohrmann & Borcherding (1985). The 2*2 groups of the sample are listed in the upper part of Table 3 (a group of risk experts was also included in order to study differences between 'laypeople' and 'experts', but this issue will not be treated here).

Most of the results obtained were in line with the presupposed theoretical framework. Given the small sample size, the study was considered as an exploratory one.

2.4 Data Collection in New Zealand

As an addition and enlargement to the initial German study, a second set of data was collected in the area of Hamilton, New Zealand (Rohrmann 1989).

A few remarks on the two countries: New Zealand and (then)(West-)Germany are about the same size but very different in population, ie, 51 vs 3.2 million inhabitants; level of industrialisation and use of technology are similar; agriculture (which is highly mechanised) is more important in NZ; human-made ecological problems seem to be slightly smaller (but natural ones are more prevalent) in NZ; enjoying and preserving nature are highly valued goals in NZ while the actual environmental policy seems to be more rigorous in Germany; nuclear energy is both considerably utilised and heavily debated in Germany, in NZ it is not at all accepted; but in general there seem to be less conflicts about technical or other hazards in NZ than in Germany; consensus as a central social value is particularly stressed in NZ (note that the study was conducted before the German re-unification and significant changes in the NZ government; nowadays further/other differences would be salient).

Initially, an English version of the Risk Evaluation Questionnaire used in the previous German study was prepared. No substantive changes were made apart from a few modifications to the instructional texts. The translation was thoroughly discussed with colleagues from the Psychology and the German Departments at Waikato University.

There were three objectives for the sampling plan: to replicate the four groups of study I as closely as possible, to enlarge the scope of the sample, and possibly to obtain larger numbers of respondents.

Two groups sharing '*feminist*' views were added: female employees who were members of women's groups etc, and female students enrolled in the department of women's studies. This was done because of findings that politically or socially engaged women have specific views on technology, environmental issues and risks (see, eg, Brody, 1984; Fischer *et al.*, 1991; Kistler & Jaufmann, 1990; Pilisuk *et al.*, 1987; Savage, 1993).

Furthermore, research on decision making and risk taking of managers (see, eg, Keyes, 1985; March & Shapira, 1987; McCrimmon & Wehrung, 1990; Shapira, 1986) suggests that people regularly dealing with '*monetarian*' issues have developed specific perspectives on risk evaluation and are less inclined to comply with 'ideological' positions. The two recruited groups consist of bank employees and students enrolled in subjects such as Accounting or Finance.

Finally, the group of "ecologically oriented" students was enlarged, consisting of those who had participated in courses in geography/environmental planning or in environmental psychology (in departments such as sociology, political science, geography, psychology, education etc, most students usually hold 'ecological' values, which was by and large true of both the German and the New Zealand sample).

In the described group set, gender is inevitably confounded with the ideological/professional factor; thus the possible impact of sex roles has to be considered.

A total of 278 respondents participated; see the second column in Table 3 for the resulting sub-samples.

2.5 Further Data Collections

At present, the project is continuing in Australia (ROHRMANN in press). The NZ set of 4x2 groups of respondents was fully repeated, based on samples collected in Melbourne and Brisbane (cf Table 3).

Furthermore, an update of the German data set was accomplished, ie, groups with a "feminist" and a "monetarian" orientation were sampled, expanding the possibilities for cross-national comparisons.

It is planned to extend the project by looking at 'non-western' cultures. The next step will be to collect a data set from Chinese respondents (in collaboration with Beijing University).

2.6 Propositions

The main propositions of the first study had been that qualitative risk aspects, rather than (assumed) fatality rates determine risks judgments; that the structure of risk evaluations is dependent on the type of the risk source; and that attitudes towards environment, technology and society strongly influence risk ratings and risk acceptance (cf Figure 1). With respect to the data collected in New Zealand, the following deviations from the German results were expected:

- Risk evaluation in general: lower risk magnitude ratings and higher risk acceptance. Reasons: in NZ, the societal risk debate has not yet developed as far as in Germany; also, "safety thinking" seems to be less predominant.
- Specific risk sources: Less negative evaluations for private activities (eg, sport risks, health risks); higher acceptance of natural hazards, lower acceptance of large-scale technologies (in particular nuclear power plants). Reasons: New Zealanders have some propensity for extreme sports (eg, bunji-jumping, parachuting, white-water rafting, etc); health movements are less strong than in Germany; hazards such as volcanism, land slides, earthquakes etc are quite familiar in NZ; large-scale industrial facilities are rare and not very much wanted; and anti-nuclear attitudes have a remarkable tradition in this country.
- Sub-groups: Same overall structure, ie, more risk-averse ratings with "environmentalists" than "technology-oriented" people; however, less polarisation between groups in NZ than in Germany. Reasons: consensus in political/social issues is an emphasised value in NZ, the risk debate is less 'heated', and ecological groups tend to have rather pragmatic viewpoints.
- Co-determinants of risk evaluations: In general, a similar cognitive structure is expected, but attitudes being less significant. Reasons: To hold individualistic 'worldviews' is an appreciated attitude in NZ, and personal opinions should be less influenced by (ideologically defined) group memberships.

Of course these considerations are not hypotheses in a strict sense but rather conjectures (they mainly originate from informal discussions with social scientists in NZ). Also, altogether sub-cultural disparities are expected to be larger than cross-national differences.

3 RESULTS

3.1 Data Analysis: Overview

The statistical analyses of the collected data is quite laborious, as 11 judgmental aspects, 8 sets of risk sources and 4x2x3 groups of respondents are to be considered. In this report, two main types of results are considered: Mean ratings and differences of group means for various sets of respondents (available for all risk aspects and sources); and analyses of the cognitive structure of risk evaluations, based on correlations among risk sources.

It should be noted that these correlations can be (and have been) determined in several ways:

- *Across risk sources*: the respective correlation matrix could be computed for each respondent or for mean data decks (either means of the whole sample or for means of specific subgroups);

- *Across respondents*: an analogous matrix could be computed for each risk source or mean ratings based on defined sets of risks.

The results presented in this chapter will focus on a comparison between New Zealand and German data, mainly based on the four subgroups available in both data sets. Demographic information about the groups is presented in Table 4.

The attitude means, in particular, illustrate the clear differences between "technologically" and "ecologically oriented" respondents (which are greater for German than for NZ groups). The feminists' characteristics are similar to those of the ecologists, while the "monetarian" group is comparable to the technological group.

Table 4: Some demographic characteristics of the respondents

Country:	New Zealand				Germany	
Subgroup:	Techn.	Ecol.	Fem.	Mon.	Techn.	Ecol.
Age	30.2	33.7	35.9	29.2	29.8	29.8
Sex (% Male/Female)	97/3	48/52	0/100	56/44	100/0	50/50
Employees/Students (%)	52/48	40/60	70/30	52/48	50/50	50/50
Attitudes (means) towards						
Impacts of technology (AIT)	3.1	3.9	3.9	3.2	2.7	4.6
Environmental concern (AEC)	4.6	5.3	5.2	4.4	4.3	5.8
Societal values (ASV)	4.7	5.4	5.3	4.2	4.6	5.6

Note: The attitude scores are based on 9/7/5 items which were measured on 7-point scales (1..7); where necessary, employees and students have been equally weighted

3.2 Judgements of Risks and Benefits: New Zealand Data

The mean judgments of NZ respondents (including all 8 groups) for 24 risk sources are given in Table 5. Overall, the following risks get the most negative evaluations in terms of perceived risk magnitude <OR>, health impacts <HI> and (non-) acceptability <IA/SA>: long-term heavy smoking, working in asbestos production, living in polluted urban areas, and nuclear power. These risk sources also induce the most fear associations <FA>.

Table 5: Risk ratings: Means for 11 risk aspects (8 NZ groups, N=278)

OR = Overall risk magnitude rating
PD = (Assumed) Probability of dying
HI = (Danger of) Health impacts
CP = Catastrophic potential
FA = Feelings of anxiety about risk
IB = Individual benefit (of activity)
SB = Societal benefit (of activity)
IA = Individual risk acceptance
SA = Societal risk accept.
PR = Pers. rel. to risk
DM = Desire to move

Var.	RM	PD	HI	CP	FA	IB	SB	IA	SA	PR	DM	
Haz.												
A	6.0	3.5	2.9		6.6	7.4	2.2	7.8	6.2	3.2		Parachuting
B	6.6	4.1	3.9		5.9	7.4	2.5	7.6	5.7	2.5		Car racing
C	5.2	2.5	3.3		4.9	7.5	2.6	8.0	6.7	3.5		Skiing
D	8.3	5.4	7.4		7.9	3.2	3.3	3.5	2.6	1.1		Asbest. prod.
E	5.8	2.7	4.9		4.8	5.5	7.2	5.4	6.8	2.1		X-ray lab
F	5.8	2.3	5.4		5.0	3.9	5.5	4.9	5.6	2.3		Compr. tools
G	8.9	6.4	8.5		8.4	2.8	0.9	5.2	1.4	4.2		Smoking
H	8.1	5.2	7.5		8.0	2.9	1.6	5.0	2.0	2.4		Tranquilizers
I	7.6	5.0	7.2		6.4	3.2	1.6	5.7	3.0	4.6		Overeating
K	6.3	3.7	4.7		5.8	7.1	8.6	6.7	8.5	1.9		Fire fighter
L	6.1	3.6	4.7		5.7	4.9	5.7	5.7	5.8	1.2		Blaster
M	5.5	3.9	3.4		5.6	8.0	8.7	7.0	8.8	1.3		Emerg. helic.
N	4.7	2.2	4.3	4.1	4.2		5.9	4.6	4.9	2.2	5.7	Coal p. plant
O	4.9	2.2	4.3	4.3	4.4		6.5	4.6	4.8	1.6	6.1	Metal prod.
P	4.6	1.7	3.6	5.1	4.5		7.1	5.2	5.2	2.8	6.8	Airport
Q	6.8	3.6	3.1	5.4	5.8			5.2	3.9	1.2	6.6	Avalanche area
R	6.3	3.1	2.9	7.0	5.2			5.7	4.9	5.3	5.3	Earthquake ar.
S	4.8	2.5	2.6	3.9	4.0			6.0	5.5	2.2	4.4	El. storms ar.
T	6.1	3.1	3.4	6.0	6.0		3.7	4.0	3.4	0.9	6.9	Explos. fact.
U	7.7	4.0	5.5	9.1	8.3		3.7	3.2	2.3	1.0	8.8	Nucl. p. plant
V	6.6	3.3	4.8	6.9	6.6		6.0	3.8	3.5	1.6	7.6	Chem. industry
W	7.2	3.6	6.3	6.4	6.9			3.9	3.0	3.5	8.2	Poll.urb. area
X	6.5	3.2	5.8	5.5	6.2			4.6	3.8	2.8	7.6	Unh. climate
Y	6.9	3.5	5.6	5.9	6.4			4.3	3.4	1.4	7.2	Nat. radiation
$\overline{X}$	6.4	3.5	4.8	5.8	6.0	5.3	4.6	5.3	4.7	2.4	6.8	(Mean)

NOTES
Variables PR and DM were not measured for the "Mon." group, i.e. these means are based on N=224 respondents.
Abbreviations: cf. fig. 2 and table 2. Empty cells: not measured.

Less adverse ratings are given to skiing, flying an emergency helicopter, coal power plants and living in electric storm areas. For sporting activities, a positive individual benefit <IB> is seen, and for public service professionals (eg, fire fighters) both individual and societal benefits <SB> are highly valued. Commonplace technical facilities (eg, airports, chemical industry) are accepted as fairly beneficial as well.

The personal risk exposure <PR> is rather low for most risk sources; the highest scores are for smoking, overeating and the earthquake hazard.

In terms of general risk *characteristics*, the (predetermined) classification of risk sources turned out to be effective: analyses of variance show significant effects of the four factors for most of the risk variables (on average, activity-related risks, hazards with chronic impacts, occupational risks and technology-induced hazards get more negative evaluations). However, these aspects will not be treated here in detail.

3.3 Comparison of German Vs NZ Mean Ratings

In Table 6, selected NZ results (computed for the four comparable groups only) are contrasted with the previous German results.

Table 6: Mean risk ratings: Comparison NZ/FRG for 6 aspects (N=130/80)

Var.	OR Overall R. Magn.		HI Health Impacts		FA Feel. of Anxiety		SB Societal Benefit		IA Ind. R. Accept.		SA Soc. R. Accept.		
Data	*FRG*	*NZ*	*FRG*	*NZ*	*FRG*	*NZ*	*FRG*	*NZ*	*FRG*	*NZ*	*FRG*	*NZ*	
Hazard													
A	5.3	5.8	3.1	2.7	5.6	6.3	1.1	2.2	7.4	7.5	5.3	6.4	Parachuting
B	7.5	6.4	5.1	3.8	6.0	5.6	1.4	2.5	6.4	7.4	3.3	5.7	Car racing
C	5.3	5.1	4.0	3.3	4.6	4.5	1.6	2.6	7.4	7.7	5.2	7.0	Skiing
D	8.0	8.2	7.4	7.2	7.1	7.7	4.2	3.4	3.4	3.6	3.2	2.8	Asbest. prod.
E	5.8	5.4	5.7	4.4	5.1	4.6	7.2	7.4	5.4	5.5	6.4	7.2	X-ray lab
F	6.2	5.7	6.4	5.4	5.1	4.7	5.6	5.9	4.2	5.0	4.6	6.0	Compr. tools
G	8.0	8.9	7.4	8.5	5.9	8.4	0.9	0.7	3.7	4.7	1.6	1.5	Smoking
H	7.8	7.8	7.4	7.2	6.7	7.8	1.0	1.8	3.3	4.6	1.7	2.3	Tranquilizers
I	7.3	7.4	6.6	6.9	5.1	6.1	1.4	1.5	3.9	5.2	2.3	3.0	Overeating
K	4.5	6.3	3.3	4.7	4.2	5.6	8.7	8.7	7.7	6.5	8.7	8.5	Fire fighter
L	4.2	5.7	3.3	4.4	4.3	5.4	6.1	6.2	6.5	5.6	6.7	6.2	Blaster
M	3.7	5.6	2.2	3.5	3.7	5.7	8.8	8.6	8.1	6.8	8.8	8.7	Emerg. helic.
N	5.6	4.3	3.9	3.8	4.0	3.7	7.2	6.1	4.5	4.8	4.9	5.2	Coal p. plant
O	5.6	4.5	4.2	3.9	4.2	4.0	7.6	6.8	4.3	4.8	4.7	5.1	Metal prod.
P	5.5	4.4	4.3	3.5	4.3	4.3	5.8	6.8	3.8	5.2	3.8	5.3	Airport
Q	5.5	6.7	2.0	2.7	4.4	5.5			5.2	5.2	4.8	4.1	Avalanche area
R	6.0	5.8	2.2	2.4	5.5	4.5			5.1	5.9	4.6	5.4	Earthquake a.
S	2.6	4.2	1.1	2.0	2.2	3.1			7.5	6.2	7.6	6.0	El. storms ar.
T	4.9	5.6	2.1	2.9	4.6	5.3	3.8	4.0	4.5	3.9	4.4	3.8	Explos. fact.
U	6.1	7.0	3.7	4.7	6.2	7.7	5.0	4.4	4.0	3.3	3.6	2.6	Nucl. p. plant
V	6.1	6.0	4.2	4.1	5.6	5.8	6.5	6.5	3.7	4.0	3.8	3.9	Chem. industry
W	6.3	7.0	5.2	6.0	5.3	6.7			3.7	3.9	3.6	3.2	Poll.urb. area
X	5.4	6.3	4.2	5.5	3.8	5.6			5.1	4.7	5.0	4.1	Unh. climate
Y	4.8	6.4	3.7	5.0	3.9	5.6			5.3	4.5	5.3	3.9	Nat. radiation
$\bar{X}$	5.8	6.1	4.3	4.5	4.9	5.6	4.7	4.8	5.2	5.3	4.8	4.9	(Mean)

Note: Results on the statistical significance of both country and group differences are given in table 8.

This cross-cultural comparison yields interesting differences: For example, the respondents from the NZ groups reveal more acceptance <IA, SA> for sport-related risks (eg, car racing or skiing) and other unhealthy private behaviours (eg, overeating), and they give lower risk ratings <OR, PD, HI, CP> for 'conventional' technologies (eg, X-ray labs, coal power plants, airports). In contrast, risk-exposed occupations (even those of high social benefit, eg, fire fighting), environmental pollution and a large-scale technology such as nuclear energy get worse evaluations than by the respondents from Germany. However, the latter difference is not as large as expected, given the determined NZ policy against nuclear power.

Finally, there appears to be no difference in risk sensitivity between the NZ and the German groups: the general range of the responses is similar in both data sets, and the overall mean of all risk ratings is approximately the same (6.1 vs 5.8 for <OR>, 5.3 vs 5.2 for <IA>). Thus the assumed overall difference in risk acceptance was not proved.

3.4 Differences Among Societal Groups

As explained above, considerable differences among groups bound to distinct societal orientations were expected (and had actually been found in the initial German study). Because of the large data set, only selected results can be given here - see Tables 7 and 8. For three risk aspects, the means for the NZ subgroups are given in Table 7 while Table 8 lists NZ versus German means (for groups included in both countries). For subgroup comparisons, employees and students were pooled.

Table 7: Mean risk ratings: Selected NZ subgroup data

Var.:	RM Risk Magnitude				SB Soc. Benefits				IA Ind. Risk Accept.			
Group	*Tec*	*Mon*	*Eco*	*Fem*	*Tec*	*Mon*	*Eco*	*Fem*	*Tec*	*Mon*	*Eco*	*Fem*
Hazard												
A Parachuting	5.5	6.2	6.1	6.7	2.4	2.2	2.0	2.6	7.2	8.0	7.8	8.0
B Car racing	6.1	6.6	6.7	7.0	3.3	2.8	1.8	2.2	7.2	7.9	7.6	7.6
C Skiing	5.2	5.4	5.1	5.1	2.9	2.9	2.4	2.7	7.4	8.1	7.9	8.3
D Asbest. prod.	7.8	8.7	8.5	8.5	4.0	3.3	2.7	3.1	3.5	3.6	3.7	3.4
E X-ray lab	4.9	6.1	6.1	6.1	7.3	7.0	7.4	7.3	5.6	5.4	5.4	5.1
F Compr. tools	5.2	5.7	6.2	6.1	6.1	5.3	5.7	5.3	5.3	5.1	4.7	4.5
G Smoking	8.7	9.3	9.0	8.8	0.7	1.6	0.7	0.8	3.9	5.1	5.6	5.7
H Tranquilizers	7.6	8.4	8.1	8.3	1.8	1.9	1.8	1.3	4.2	5.1	5.1	5.3
I Overeating	7.1	7.7	7.7	7.8	1.8	2.5	1.2	1.5	4.7	5.9	5.7	6.3
K Fire fighter	6.0	6.4	6.5	6.3	8.6	8.5	8.8	8.6	6.4	6.9	6.5	7.0
L Blaster	5.5	6.2	6.0	6.4	6.3	5.3	6.1	5.4	6.0	5.7	5.3	5.8
M Emerg. helic.	5.3	5.3	5.9	5.6	8.3	8.9	8.8	8.8	6.8	7.3	6.8	7.3
N Coal p. plant	3.6	4.8	5.0	5.0	6.6	5.7	5.6	5.7	5.3	5.0	4.3	4.3
O Metal prod.	3.8	4.7	5.3	5.4	7.1	6.3	6.4	6.1	5.3	5.0	4.3	4.2
P Airport	3.8	4.0	5.0	5.0	7.0	7.7	6.7	7.0	5.5	6.0	4.8	4.8
Q Avalanche a.	6.2	7.3	7.1	6.8					5.2	5.4	5.2	4.9
R Earthquake a.	5.3	7.0	6.2	6.5					6.1	5.8	5.7	5.2
S El.storms ar.	4.0	5.2	4.5	5.5					6.4	6.0	6.0	5.7
T Explos. fact.	5.1	6.0	6.2	6.9	4.5	3.6	3.5	3.1	4.2	4.4	3.6	3.7
U Nucl. p. pl.	5.7	7.9	8.2	8.6	6.0	3.8	2.7	2.4	3.6	3.5	2.9	2.8
V Chem. ind.	5.1	6.9	7.0	7.5	7.2	5.8	5.7	5.6	4.3	4.2	3.7	3.4
W Poll.urb. ar.	6.6	7.1	7.4	7.4					4.0	4.4	3.9	3.8
X Unh. climate	6.2	6.4	6.3	6.9					4.5	4.5	5.0	4.2
Y Nat. radiat.	5.7	7.6	7.0	7.4					4.7	4.3	4.2	3.6
$\bar{X}$ (Mean)	5.7	6.5	6.5	6.7	5.1	4.7	4.4	4.4	5.3	5.5	5.2	5.2

Abbrev.: cf. table 2; subgroups and sample sizes: cf. table 3.
Note: Subgroups of students and employees are equally weighted.

Table 8: Mean risk ratings: Comparison NZ/FRG - selected subgroup data

Group:	*Ecol. orient. (N=40/65)*						*Technol. orient. (N=40/65)*						
Var.:	OR Overall R. Magn.		SB Societal Benefit		IA Ind. R. Accept.		OR Overall R. Magn.		SB Societal Benefit		IA Ind. R. Accept.		
Data	FRG	NZ	FRG	NZ	FRG	NZ	FRG	NZ	FRG	NZ	FRG	NZ	
Hazard													
A	5.7	6.1	0.9	2.0	6.6	7.8	4.9	5.5	1.2	2.4	8.0	7.2	Parachuting
B	7.6	6.7	0.9	1.8	5.5	7.6	7.3	6.1	1.8	3.3	7.2	7.2	Car racing
C	4.8	5.1	1.0	2.4	7.0	7.9	5.7	5.2	2.0	2.9	7.7	7.4	Skiing
D	8.0	8.5	2.7	3.9	2.6	3.7	7.5	7.8	4.6	4.0	4.1	3.5	Asbest. prod.
E	6.5	6.1	7.4	7.0	4.7	5.4	5.1	4.9	7.4	7.3	6.0	5.6	X-ray lab
F	6.6	6.2	5.7	5.6	3.1	4.7	5.7	5.2	5.6	6.1	5.2	5.3	Compr. tools
G	7.9	9.0	0.7	0.9	4.0	5.6	9.0	8.7	0.8	0.7	3.4	3.9	Smoking
H	7.9	8.1	1.8	1.2	3.7	5.1	7.7	7.6	0.7	1.8	2.8	4.2	Tranquilizers
I	7.2	7.7	1.2	1.6	4.2	5.7	7.3	7.1	1.1	1.8	3.3	4.7	Overeating
K	4.7	6.5	8.8	8.6	7.1	6.5	4.4	6.0	8.7	8.6	8.2	6.4	Fire fighter
L	4.7	6.0	6.1	6.0	5.6	5.3	3.8	5.5	6.1	6.3	7.3	6.0	Blaster
M	3.9	5.9	8.8	8.8	7.8	6.8	3.5	5.3	8.8	8.3	8.3	6.8	Emerg. helic.
N	6.2	5.0	5.6	7.4	3.5	4.3	5.0	3.6	7.1	6.6	5.5	5.3	Coal p. plant
O	6.1	5.3	6.4	7.3	3.5	4.3	5.1	3.8	7.8	7.1	5.1	5.3	Metal prod.
P	6.4	5.0	6.7	5.0	2.5	4.8	4.6	3.8	6.5	7.0	5.2	5.5	Airport
Q	5.1	7.1			5.3	5.2	6.0	6.2			5.0	5.2	Avalanche area
R	5.8	6.2			4.8	5.7	6.2	5.3			5.3	6.1	Earthquake a.
S	2.7	4.5			7.2	6.0	2.4	4.0			7.7	6.4	El. storms ar.
T	5.5	6.2	3.5	3.5	3.5	3.6	4.6	5.1	4.1	4.5	5.5	4.2	Explos. fact.
U	7.7	8.2	2.7	2.9	2.3	2.9	4.6	5.7	7.0	6.0	5.7	3.6	Nucl. p. plant
V	6.9	7.0	5.7	5.7	2.5	3.7	5.5	5.1	7.2	7.2	4.9	4.3	Chem. industry
W	7.2	7.4			2.9	3.9	5.4	6.6			4.6	4.0	Poll.urb. area
X	5.7	6.3			4.6	5.0	5.1	6.2			5.5	4.5	Unh. climate
Y	5.3	7.0			4.7	4.2	4.6	5.7			5.8	4.7	Nat. radiation
$\bar{X}$	6.1	6.5	4.3	4.4	4.4	5.2	5.4	5.7	4.9	5.1	5.4	5.3	(Mean)

Note: For significance tests see table 9.

The results of significance tests (ANOVAs, related to Tables 6, 7 and 8) are depicted in Table 9, where the symbol "#" denotes group differences and "x" interactions between group and country.

Table 9: Mean risk ratings: Significant differences for NZ/FRG and subgroups

Var.	OR Overall R. Magn.			HI Health Impacts			FA Feel. of Anxiety			SB Social Benefit			IA Ind. R. Accept.			SA Soc. R. Accept.			
Sign.	C	G	CxG	C	G	CxG	C	G	CxG	C	G	CxG	C	G	CxG	C	G	CxG	
Hazard																			
A		#							x	**					x	*			Parachuting
B	**			**				#		**	##		*		x	**	##		Car racing
C				**						**	#					**			Skiing
D		##						##		**	##						#		Asbest. prod.
E		##		**	##			##								*			X-ray lab
F		##		**	#			##					*	##		**	##		Compr. tools
G				**			**							##					Smoking
H							**			**			**						Tranquilizers
I							*					x	*			*			Overeating
K	**			**			**		x				**						Fire fighter
L	**			**	#		**		x				*	##			#		Blaster
M	**	#		**			**		x				**						Emerg. helic.
N	**	##			##			##		**		x		##			##		Coal p. plant
O	**	##			##			##		**	##			##			##		Metal prod.
P	**	##		*	##	xx		##		**	##	x	**	##	xx	**	##		Airport
Q	**		xx	*			**									*			Avalanche area
R			x				**						*			*			Earthquake a.
S	**			**			**						**			**			El. storms ar.
T	*	##		**	##			##			##			##			##		Explos. fact.
U	**	##		*	##		**	##			##			##	xx	**	##	xx	Nucl. p. plant
V		##			##			##			##			##	x		##		Chem. industry
W	**	##	x	*	##		**	##							x		##	x	Poll.urb. area
X	**			**			**								x	**			Unh. climate
Y	**			**	#		**	##					*			**	##		Nat. radiation

"*/#/x": p[Ho] < .05; "**/##/xx": p[Ho] < .01 or .001. Significances computed by univariate two-way analyses of variance with factor C = country (NZ/FRG; N=130/80) and factor G = societal sub-group ("technological" vs. "ecological" orientation; N=65/65 for NZ and 40/40 for FRG data).
Note: Corrections of the alpha values with respect to multiple testing effects were not considered here.

The findings of group comparisons can be summarised as follows:

- People with an "ecological orientation" evaluate risks much more critically than those with a "technological orientation": for most risk sources, their ratings on all riskiness scales <OR, PD, HI, CP> and feelings of anxiety <FA> are higher, while benefit judgments <IB, SB> and risk acceptance <IA,SA> are lower. The overall means in Table 8 also demonstrate the described group pattern for both German and NZ data.
- However, there are remarkable exceptions. For example, with respect to smoking, tranquillisers and overeating, engineers and technology students express more concern than the environmentalists or psychology/geography students in the study.
- The described inter-group differences are much stronger for the German than for the NZ data; obvious examples are the acceptability ratings for technological risks such as X-rays, compressor tools, airports, chemical industry and particularly nuclear power plants (see also the interactions listed in Table 9). These data demonstrate that (as predicted) group polarisation is considerably lower in NZ.
- The group with a "feministic orientation", as studied in New Zealand, evaluates risks rather similar to ecologists, although they tend towards higher risk magnitude ratings <OR>. (Interestingly, the highest acceptance for risky private activities, eg, skiing or smoking, is found in the "feminists' data.)
- The pattern of results for the "monetarian" respondents tends to fall between the technological and ecological groups; examples are their judgements of technological hazards. Rather high risk magnitude ratings are given for some natural risks, possibly because of the enormous costs related to those hazard (for example, earthquakes). However, in general, extreme judgements are less likely with this group.
- Group differences with respect to employees vs students were also analysed. The effects were smaller than expected and non-significant for most risk sources and risk aspects. Thus the respective subgroups were pooled.

In summary: in the present data deck, differences among societal/ideological groups are rather larger than cross-national differences, and the patterns are generally similar in the German and the NZ data.

Note: Analyses of the data collected in Australia (cf Rohrmann (in press) indicate quite similar results compared to the NZ findings.

3.5 Subjective Determinants of Risk Evaluations

In order to study the cognitive risk evaluation process, the correlations among risk aspects were analysed. Tables 10 and 11 present some results (those computed across risk sources) for German and NZ respondents, based either on intra-individual data or averaged ratings. (As usual, the mean data sets yield higher values.) There are rather high intercorrelations within risk magnitude variables <OR, PD, HI, CP> and between perceived benefits and risk acceptance <IB, SB, IA, SA>. Affective reactions, such as feelings of anxiety or desire to move <FA, DM>, are correlated with both risk magnitude and risk acceptance.

Table 10: Intercorrelations of risk aspects via sources for NZ and FRG data

	OR	PD	HI	CP	FA	IB	SB	IA	SA	PR	DM
OR	≡≡	92	79	75	92	-75	-62	-36	-65	11	70
PD	22	≡≡	73	59	84	-58	-55	-17	-49	09	48
HI	78	10	≡≡	33	73	-93	-46	-47	-60	16	76
CP	73	25	38	≡≡	85			-62	-75	03	68
FA	77	42	56	95	≡≡	-59	-57	-38	-61	-04	89
IB	-55	55	-83		-26	≡≡	40	93	84	-19	
SB	-67	-37	-59		-47	31	≡≡	01	66	-54	
IA	-67	40	-65	-56	-37	88	34	≡≡	75	29	-86
SA	-84	-14	-66	-77	-67	48	74	76	≡≡	-08	-89
PE	21	28	30	43	00	-22	-10	-53	-41	≡≡	-30
DM	80	-02	81	71	67			-80	-86	65	≡≡

Correlations based on mean ratings for 24 risk sources; above diagonal: NZ data (N=130, groups "Tec" + "Eco"); below diagonal: FRG data (N=80).
Empty cells: Correlation cannot be computed. - Coefficients multiplied by 100. For abbreviations cf. table 5 or fig. 1.
Note: Variables CP, IB and DM are defined for 12 sources only; SB is defined for 18 sources (cf. table 4).

Table 11: Mean individual intercorrelations of risk aspects via sources for NZ and FRG data

	OR	PD	HI	CP	FA	IB	SB	IA	SA	PE	DM
OR	≡≡	58	59	52	63	-44	-41	-33	-46	-05	65
PD	40	≡≡	57	41	54	-34	-23	-21	-34	-06	48
HI	64	34	≡≡	33	57	-64	-33	-33	-45	-01	59
CP	46	31	31	≡≡	64			-32	-42	-03	50
FA	60	42	51	62	≡≡	-38	-38	-29	-45	-12	78
IB	-31	20	-46		-21	≡≡	40	51	71	-01	
SB	-40	-27	-36		-32	13	≡≡	18	52	-38	
IA	-47	-14	-43	-42	-39	54	27	≡≡	59	11	-62
SA	-57	-18	-49	-46	-44	48	60	66	≡≡	03	-63
PE	11	-02	16	20	05	-06	00	-10	-18	≡≡	-24
DM	60	37	61	49	71			-68	-65	25	≡≡

For each variable pair, the median of the N individual correlations is presented; above diagonal: NZ data (N=130, groups "Tec" + "Eco"); below diagonal: FRG data (N=80).
Empty cells: Correlation cannot be computed. - Coefficients multiplied by 100.
Note: Variables CP, IB and DM are defined for 12 sources only; SB is defined for 18 sources (cf. table 4).

The assumptions shown in the theoretical framework (see Figure 1) were then analysed by means of multiple regression. Due to space restrictions, only those computed across respondents are presented in Table 12.

Methodological note: in this case, person-related variables, particularly attitude measures, can be included in the analysis, which is not possible if correlations across risk sources are used.) The analyses in Table 12 were conducted for a specific set of risk sources (N+P+V, ie, coal power plant, airport, chemical industry) which represent central environmental problems such as air pollution, noise and water pollution.

Table 12: Single and multiple correlations among risk aspects

Risk source: N+P+V; Correlations across respondents

	Data/group:	*NZ-4 (Env.+Techn.)*				*NZ/E*	*NZ/T*	*NZ/F*	*FRG*			
	N:	130				65	65	67	80			
	Criterion:	OR		IA		OR	OR	OR	OR		IA	
	Mult. R:		65		42	57	63	65		54		60
	Significance:		**		*	**	**	**		**		**
Predictors:		r-PC	Beta	r-PC	Beta	r-PC	r-PC	r-PC	r-PC	Beta	r-PC	Beta
PD	Prob. of dying	53	16	-34		46	53	46	38	13	-37	
HI	Health impacts	60	44	-38		55	58	46	48	26	-39	
CP	Catastr. potent.	36	04	-16		32	27	60	32	20	-34	
EA	Ecol. attitude	25	21	-25	-10	03	17	03	44	25	-49	-24
OR	Risk magnitude	≡≡		-35	-24	≡≡	≡≡	≡≡	≡≡		-49	-28
FA	Feel. of anxiety	57		-32	-13	50	50	63	56		-42	-14
SB	Societal benefit	-08		20	14	05	00	-17	-21		36	14

Criterion OR = Overall risk magnitude rating; IA = Individual risk aceptance.
r-PC = single correlation between predictor and criterion.
Beta weights are computed for theoretically assumed determinants only.
Note: All coefficients multiplied by 100.

The results demonstrate the following:

- Concern for health impacts <HI> is a better predictor of the perceived risk magnitude <OR> than "probability of dying" <PD>, the 'classical' risk indicator.
- Individual risk acceptance <IA> is significantly determined by risk magnitude <OR>, social benefit <SB> and feelings of anxiety <FA>.
- Attitudes towards environmental issues, impacts of technology and social values (aggregated into the overall ecological attitude <EA>) have considerable influence on both risk magnitude and risk acceptance.
- The correlational structure is roughly similar for the considered subgroups (due to space limitations, only one example is given in Table 12). Looking at risk magnitude <OR>, two exceptions should be noted: For feminists, negative associations with risk sources such as catastrophic potential <CP> and feelings of anxiety <FA> are particularly important co-determinants; and attitudes are not predictive within subgroups (possibly because of the reduced intra-group variance).

These findings elucidate the factors contributing to the 'intuitive' risk concept which people develop within their specific cultural context.

3.6 Structural Differences between German and NZ Judgements

The correlations and multiple regressions in Table 12 also indicate some cross-national differences. The most obvious one is that the ecological attitudes <EA> are less predictive for risk evaluations (both <OR> and IA>) in the NZ than in the German data. Two explanations are possible: either the included attitudinal variables actually have less influence, and/or the scales employed (which were developed for German respondents) are not sufficiently valid for New Zealanders. Furthermore, the intercorrelations between the negative aspects of risks <OR, PD, HI, CP, FA> tend to be higher for NZ than for the German data, indicating less differentiated judgments in the NZ case.

Nevertheless, the overall structure of judgments about risks seems to be similar for the NZ and German respondents. This structure was then analysed by means of the LISREL approach (Jöreskog & Sörbom, 1983 & 1987). Its purpose is to identify "linear structural relationships" among constructs on the basis of a hypothesised theoretical model.

In Figure 2 an analysis is shown which was computed with the German data (cf Borcherding *et al.*, 1986; values on the left in the graph) and which has now been repeated with the NZ data (values on the right). It is restricted to the three environmental risk sources mentioned above (N, P, V). The constructs included in the structural model represent the core of the framework in Figure 1; the measurement model is based on source-specific judgments (for <PD, HI, OR, SB, IA>) or on domain-specific attitudes (for <EA>).

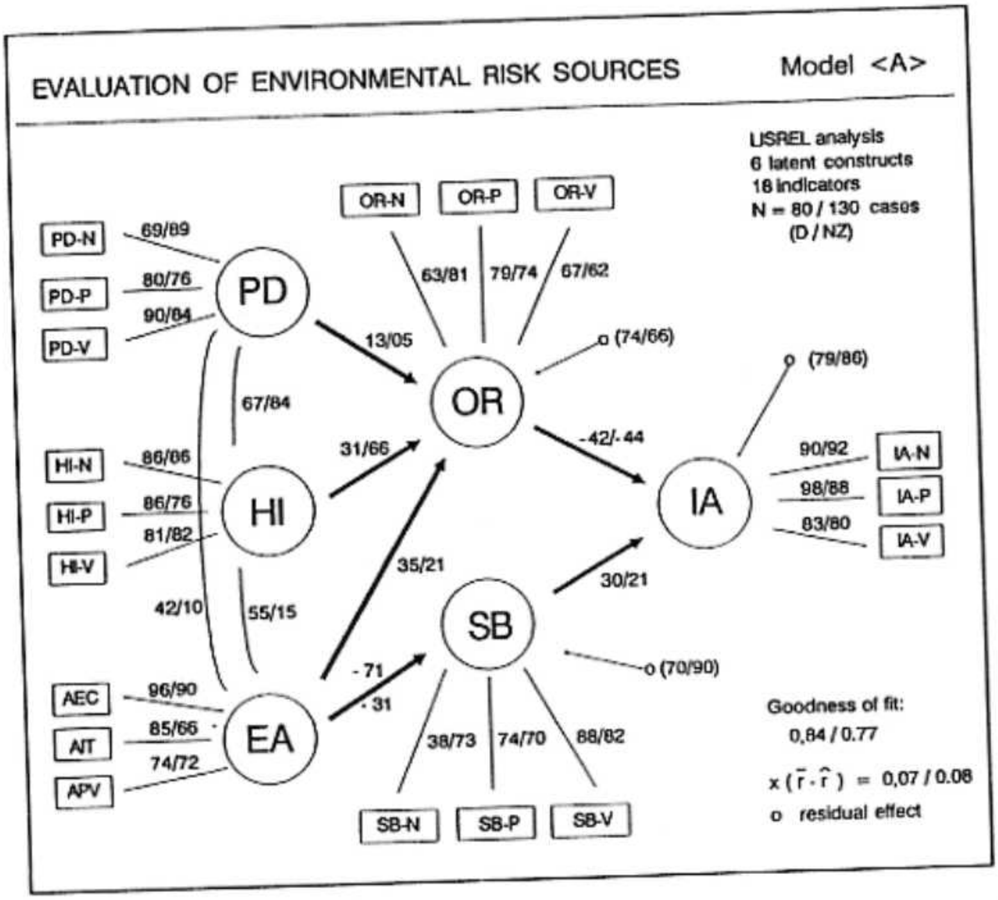

Figure 2: Analysis of a structural model <A> for the evaluation of 3 environmental risk sources, using German and NZ data

The results again demonstrate that, as predicted, risk acceptance <IA> is determined by perceived risk magnitude <OR> and benefit considerations <SB>, that fear of health impacts <HI> is more important than probability of dying <PD>, and that attitudes such as environmental concern, negative evaluations of technology and 'post-material' value orientations have considerable influence.

The NZ data yield somewhat different outcomes: Attitudes are less relevant, and the effect of probability of dying disappears (as <PD> is highly correlated with <HI>, it has no independent impact on <OR> anymore).

It should be noted that the "fit" of the model is only moderate, particularly with the NZ data (yet for comparability reasons the replicated model was not modified). The mean difference between the empirical correlation matrix and the respective model-derived coefficients is 0.07, indicating a fair correspondence.

A second LISREL model is presented in Figure 3. Six risk sources (N, O, P, U, V, T) are used and directly aggregated to additive sum variables; the ecological attitudes are integrated into a factor score. Societal risk acceptance <SA> is introduced as a final dependent variable. The model elucidates the significance of anxiety feelings <FA> for risk judgments. Catastrophic potential <CP> is influencing the risk magnitude rating <OR> (which was predicted) but also anxiety feelings <FA>.

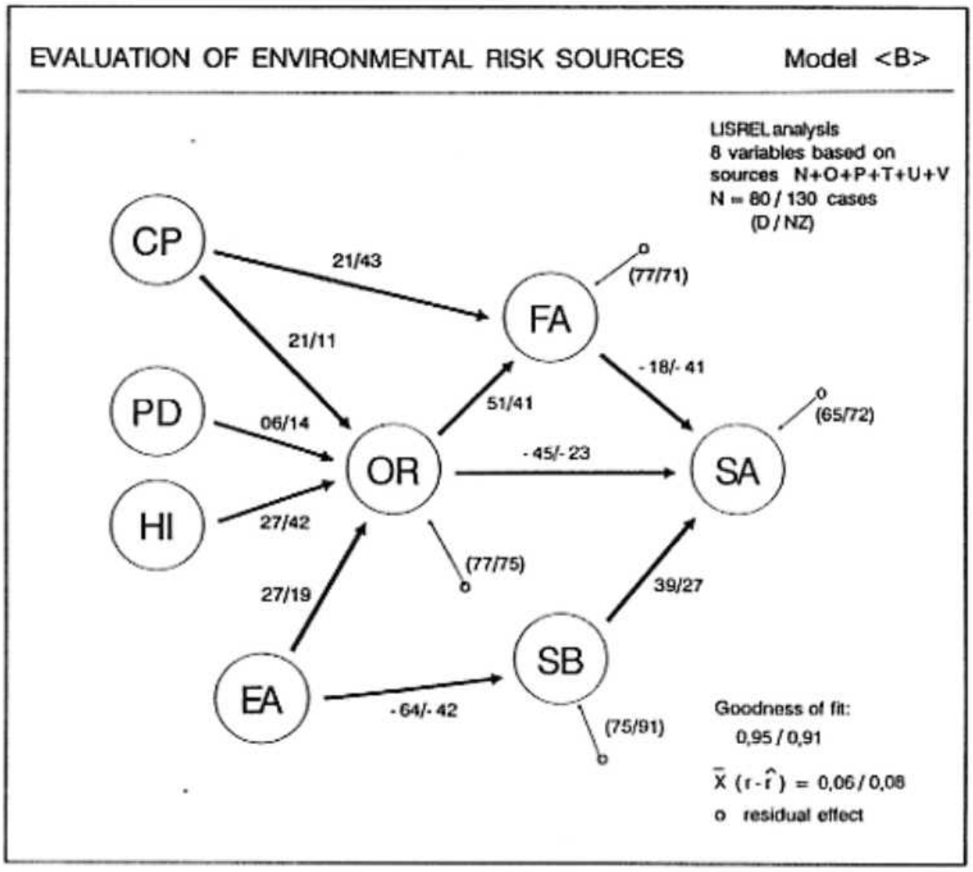

Figure 3: Enlarged structural model <B> for the evaluation of 6 environmental risk sources, using German and NZ data

The structure obtained for German and NZ data is roughly similar, however, the relative ranks of the four predictors considered for risk magnitude <OR> and of the three predictors for risk acceptance <SA> are somewhat different.

Altogether the differences between German and NZ judgments do not form a clear picture but it seems that for New Zealanders technology-related value orientations (such as <EA> or <SB>) have a smaller influence on risk evaluations than in Germany while 'affective' aspects (such as <FA>) are more important.

3.7 Summary of Results

In short, the analyses presented here demonstrate the following:

- Risk judgments, eg, risk magnitude ratings or risk acceptance, are considerably influenced by subjective aspects such as health concerns or feelings of anxiety and particularly ecological attitudes.
- There is no overall difference in risk judgments between the NZ and the German data but specific types of risks get significantly different ratings.
- Group differences in evaluating risks are considerable, with the 'technologically oriented' or the 'monetarian' group showing less negative judgments than 'ecologists' or 'feminists'. In general, these effects are larger than country-related variance.
- Inter-group differences are more evident in the German than in the NZ data, ie, group polarisation is lower in New Zealand.
- The cognitive structure of subjective risk evaluations (as analysed by multivariate structural modeling) is generally analogous in the NZ and the German case yet attitudinal influences are less salient with the NZ respondents.

In summary, most of the assumed cultural differences in judging risks could be shown in this study.

4 CONCLUSIONS

4.1 Interpreting Risk Perception Studies

As many authors have noted, the 'technical'/'quantitative' approach of risk analysis is inadequate to reflect the complex pattern of individual risk evaluations (eg, O'Riordan, 1983; von Winterfeldt & Edwards, 1984; Jungermann & Slovic, 1993; Renn, 1992). How people think about the magnitude and the acceptability of risks and how they make their respective judgments and decisions is influenced by knowledge, values and feelings. They include a variety of 'qualitative' consequences of risky activities or living conditions beyond hazard scenarios, fatality probabilities and so on. As others, this study has demonstrated the "social construction of risk" (Johnson & Covello, 1987) and clarified the crucial role of societal and psychological factors in the evaluation process.

Furthermore, the obvious differences among various groups of respondents - cross-national and especially intra-national ones - are quite in line with the "cultural approach" of risk research (Cvetkovich & Earle, 1991; Dake, 1991; Douglas & Wildavsky, 1982; Schwarz & Thompson, 1990; Thompson, 1980; Wildavsky & Dake, 1990). Consequently, risk perception studies per se have restricted external validity. Before findings are generalised, a careful examination of the investigated sample and its cultural background is indispensable.

In this context, a comment from a 'non-American' perspective might be allowed. As in many other areas of social science, the research on risk perception done in the USA is both stimulating and somewhat dominating the field (and sometimes uncritically 'imported' into other countries). However, as risk actually is a social construction, caution is indicated in the interpretation and generalisation of specific US-American findings. The present project (as well as the various other cross-cultural risk studies mentioned above) can help to clarify what might be held as universality and what is significant for specific (sub-)cultures.

4.2 Considerations for Future Research

A number of *substantive* questions deserve on-going attention:

- The present study dealt with judgments, ie, verbal reactions to (more or less hypothetical) risk situations. How cognitions and emotions about risks are related to actual behaviour, eg, risk-avoiding activities, job change, protests against risky technologies, etc requires thorough examination.
- More social-psychological and sociological data are necessary for a comprehensive analysis of cultural influences on the interpretation of risks and risk acceptance (cf McDaniels & Gregory (1991) for a research framework).
- Causes and effects in the cognitive process underlying risk evaluations are not yet sufficiently clarified. Related to this is the cognitive representation of hazards (see, eg, Bostrom *et al.*, 1992).

Most risk perception studies have been performed in industrialised 'western' countries; other types of political/economical cultures should be considered as well.

From a *methodological* viewpoint, the empirical basis of the presented results is obviously small. Larger and more broadly defined samples are the most important objective in order to increase validity. Yet the findings gained so far should justify continuing cross-cultural risk studies.

4.3 Applicability of Findings

Research on risks related to technical facilities, environmental problems, occupational activities and so on is valuable and applicable to scientific questions as well as to political issues. Regarding psychological research on subjective risk judgments, findings are particularly relevant for a better understanding of conflicts about risk evaluation and can be applied to improving risk communication among the various parties involved (Covello *et al.*, 1986; Fischhoff *et al.*, 1993; Jungermann *et al.*, 1988; Kasperson & Stallen, 1990; Plough & Krimsky, 1987). Interactive communication and co-operative conflict resolution must be based on mutual knowledge and acceptance of the actor's way of thinking about risk (Renn, 1992; Rohrmann, 1991). The results gained in the present study can be used for such intentions.

Psychological expertise is equally important for further tasks of risk communication, such as effective information about hazards and related behaviour modification programs, because they are usually designed to change risk perception within a specific cultural context.

Profound risk management is a major challenge for modern societies. Competent knowledge about universal *and* culture-specific factors of risk perception and evaluation is a crucial supposition for that aim.

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