Perception of hazards for health and safety - social-science perspectives

Bernd Rohrmann (University of Melbourne) & Klaus Eichner (University of Hamburg)

Final report - Text RRA - Melbourne 2012
Article to be published by: Zeitschrift fuer erfahrungswissenschaftliche Sozialforschung

List of contents:

Perception of hazards for health and safety: cross-cultural social-science perspectives

Abstract

Risk perception has been a vivid area of both societal debate and social science research for two decades now. In this interdisciplinary area, psychologists, sociologists and political scientists investigate how individuals judge and evaluate hazards related to working conditions, private activities, technological developments, residential settings, environmental hazards and global ecological changes. In this article, at first the underlying conceptualizations and survey approaches are outlined, and then core results collected in several countries are described. In a special section, findings from a recent study conducted in Brazil are presented. Overall, risk perceptions are interpretations of hazards, based on exposure, personal experiences and beliefs. They are embedded in the norms, value systems and cultural idiosyncrasies of societies, and therefore vary across groups and countries. Findings are very valuable for designing comprehensive risk communication, which is an indispensable component of effective risk preparedness and disaster management.

Zusammenfassung

Risiko-Perzeption ist seit mehreren Jahrzehnten in intensives Feld sozialwissenschaftlicher Forschung. In diesem interdisziplinaeren Gebiet untersuchen Psychologen, Soziologen und Politikwissenschaftler, wie Menschen Gefahrenquellen einschaetzen und bewerten, die im beruflichen oder privaten Leben auftreten, mit technologischen Entwicklungen einhergehen, im Wohngebiet gegeben sind oder auf Umweltveraenderungen bezogen sind. In diesem Aufsatz werden zunaechst die zugrundeliegenden Konzepte und Untersuchungsansaetze erlauetert und dann wichtige Ergebnisse aus Forschung in mehreren Laendern dargestellt. Ein spezieller Abschnitt gilt Resultaten aus einer neuen Studie die in Brazilien durchgefuehrt wurde. Zusammengefasst, Risiko-Perzeption ist eine Interpretation von Gefahrenquellen, die auf deren Auftreten, persoenlichen Erfahrungen und Einstellungen beruht. Dies ist eingebunden in die Normen, Wertsysteme und kulturellen Eigenarten von Gesellschaften, und ist darum je nach Land und sozialer Gruppe unterschiedlich. Erkenntnisse sind sehr wertvoll dafuer, umfassende Risiko-Kommunikation zu gestalten, was eine notwendiger Bestand von wirksamer Vorbereitung auf Risiken und Handhabung von Disastern ist.

Perception of hazards for health and safety: cross-cultural social-science perspectives

1 PROBLEM

1.1 Risk as an issue of social-science research - Sociological and psychological perspectives

In their professional and their private world, humans are exposed to manifold hazards, including working conditions, private activities, technological developments, residential settings, environmental hazards and global ecological changes. Examples are: working with toxic materials, smoking, unprotected sex, mobile phones, chemical factories, floods, air pollution. In social-science risk research, psychologists and sociologists investigate how people think and feel about risks, which impacts on health and safety they assume, what their attitudes towards risk-taking are, how they behave when facing a risk situation, and how information and education are designed and realized to avoid or at least reduce dangerous hazard impacts.

The core area, called "risk perception", has been a vivid area of both societal debate and scientific research for two decades now. The starting point was to establish "risk" as a subjective concept, not an objective entity; to include technical/physical and social/ psychological aspects in risk criteria; and to accept opinions of "the public" (i.e., not just scientists) as the matter of interest. This approach was developed by B. Fischhoff, S. Lichtenstein and P. Slovic, the "Oregon Group".

Main issues are the cognitive structure of risk ratings, subjective concepts underlying risk judgments, the determinants of perceived risk magnitude and risk acceptance, and differences between societal groups or countries and cultures (cf., e.g., Finucane & Holup 2006, Fischhoff et al. 1982, Fischhoff et al. 1997, Rohrmann 2003, Rohrmann 2006, Rohrmann & Renn 2000, Sjoeberg 1999, Slovic 2000). While this research sphere originated in psychology, it soon became obvious how enriching sociology perspective are. The multifold findings are essential for understanding conflicts about risk acceptance and enhancing risk management.

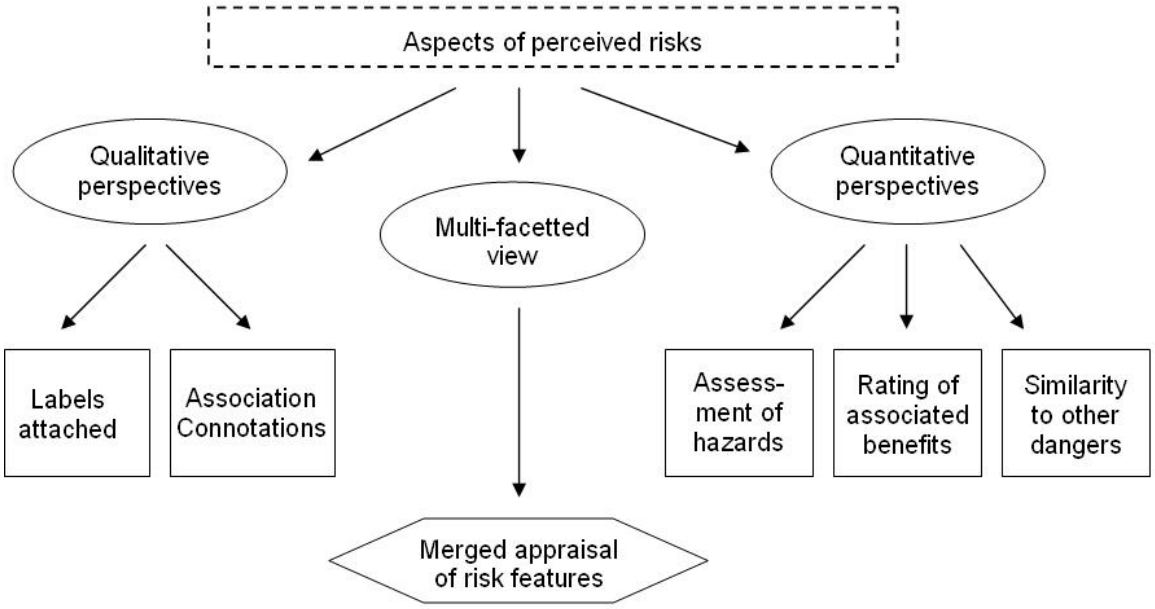
1.2 Measuring people's attitudes towards hazards

In risk perception research, the agenda is to investigate how individuals judge and evaluate hazards to which they are or may be exposed. In *Figure 1,* some main types of risk perception measures for qualitative and quantitative approaches and merged appraisals are presented.

Most studies are based on a 'psychometric' approach (sensu Slovic 1992, 2000), i.e., risk sources are scaled according to a set of substantive risk criteria. These criteria include dangers, compensating benefits of risky activities, and resulting acceptability ratings. Exploring views of the general public was a crucial step in this research field; psychometric data allow for complex analyses of both expert and lay-people judgments.

Figure 1

TYPES OF RISK PERCEPTION MEASURES



Quite a few enquiries have looked at specific hazards (cf. Baghal 2011 as an example) yet risk perception surveys require an overarching mode.

1.3 Objectives of cross-cultural risk perception studies

In a first phase, general principles of risk perception were the dominating interest. Yet people's risk appraisals may be dependent on the specific cultural background in which they grew up and reside now. Therefore risk perception research needs to reflect this sociological context. "Cross-cultural" factors can be looked at in two ways (cf. Rohrmann 2000), as shown in *Table 1*.

Table 1

NOTIONS OF "CROSS-CULTURAL" RISK PERCEPTION RESEARCH		
Level of comparison	*intra-national*	*inter-national*
Units of study	professional or ideological sub-groups of society	countries or cultures
Core variables	beliefs and attitudes towards perceived risk sources	culturally embedded values regarding safety & risk

In international studies, usually countries or cultures (e.g., "western" and "eastern") are compared. However, cultural disparities also exist within a society, and this aspect can be surveyed via relevant professional or ideological sub-groups of a nation. For example, engineers or teachers or members of a 'green' organization are likely to assess risks from hazards differently.

2 RESEARCH APPROACH

2.1 Conceptual framework

For each empirical risk perception research project a set of substantive decisions is due:

Which hazards shall be looked at and assessed by which risk aspects? How will participants of the study be sampled? Which social-science tools, e.g., questionnaires and rating scales, are needed to measure people's views? On which theory can the interpretation of findings be based? These facets will be further discussed below. For relevant literature cf., e.g., Beck 1992, Dake 1992, Fischhoff et al 1982, Kasperson et al. 1988, Rayner 1992, Renn 1992, Rohrmann & Renn 2000, Sjoeberg 2006, Slovic 1992, Weber & Hsee 2000.

Obviously a sound conceptual framework is necessary to chose valid methods and to clarify why particular risks are seen as high or not, why acceptance ratings for some hazards are not in line with scientific data (i.e., overestimating or underestimating riskiness of smoking or nuclear power), and why people are often insufficiently aware of or overly worried about risks for their health and safety.

2.2 Design: Hazards, risk judgments, respondents

The principal "problem space" of a risk perception project is outlined in *Table 2* - there are always three facets to be considered. This table is based on a series of studies by Rohrmann (cf. Rohrmann 2006), in which 24 hazards were assessed according to 12 risk aspects by 4 groups of respondents, each sampled in several countries.

Table 2

STUDY DESIGN FACETS

Problem space in studies within Project "CRH" = Cognition of risks from hazards

FACET	*Included:*	*Conceptual basis:*	*Example:*
Hazards:	24 risk sources	hazard taxonomy	earthquake
Risk features:	12 evaluation aspects	causal model of risk perception	rated magnitude
Respondents:	(A) 8 countries (B) 4 societal groups	cultural characteristics professional & political affiliations	Germany, Brazil engineers

These design features need to be maintained if cross-cultural comparisons are to be conducted. The validity of results is as substantial as the covered hazards and risk aspects are representative for the researched problem. In *Table 3* and *Table 4* essential elements are listed.

2.3 Questionnaires for surveys

In order to measure judgments about hazards (as outlined in the theoretical framework of a study) as well as relevant personal characteristics of the respondents, a standardized questionnaire is needed.

The core part is a combination of hazards and risk aspects, each pair is to be assessed on a scale, which may be a 5-point or a zero-to-ten rating scale. As personality characteristics, environmental concern, risk propensity attitudes and demographic attributes are of interest.

Table 3

HAZARDS STUDIED IN RISK PERCEPTION RESEARCH - PROJECT CRH

Research project "CRH" = Cognition of risks from hazards

Individual activities

Regularly driving in cars
Regularly partaking in high impact sports
Long-term heavy smoking
Having unsafe/unprotected sex
Eating too much and very fatty food
Consuming hallucinogenic drugs
Working in an X-ray laboratory
Working with toxic materials
Working underground as a miner
Regularly using a mobile phone
Travelling in a unstable and unsafe country
Being in places where thieves operate
Giving up a dissatisfactory but secure job
Regularly participating in gambling
Investing in an uncertain product/new firm

Residential conditions

Living in an earthquake-prone area
Living in an area prone to storms/hurricanes
Living in an area where there are landslides
Living in an area with frequent floods
Living in an area with high air pollution
Living near a large airport
Living near a coal power plant
Living near a nuclear power plant
Living near chemical industry facilities
Living in a high-crime area

Table 4

ASPECTS FOR RISK APPRAISALS - PROJECT CRH

Research project "CRH" = Cognition of risks from hazards

Aspects for evaluating the impacts of hazards: five types:

RM	Overall risk magnitude
PD	Probability of dying
HI	Danger of health impacts
EI	Economic impacts
CP	Catastrophic potential
FA	Feelings of anxiety
SB	Societal benefits
IB	Individual benefits
AA	Attractiveness of activity
SA	Societal acceptance of risk
IA	Individual acceptance of risk
NM	Necessity of risk management

Note: For ratings, a response scale 0...10 is used

An example for such an instrument is the Hazard Evaluation Questionnaire (HEQ) (cf. Rohrmann 1994). It is multi-dimensional and was carefully tested.

2.4 Sampling: Countries and social groups

As outlined above, within a country ideally a random sample of the population is to be taken, although this may be out of reach. Alternatively, social groups can be sampled for which different risk appraisals are expected (cf., e.g., Beck 1992, Chauvin et al. 2007, Rohrmann 1994, Sjoeberg 1999, Willis & Dekay 2007). Risk perception theories may also induce cross-national sampling, i.e., to explore how the health-and-safety culture of a country determines whether people accept or not a workplace or a lifestyle or an environmental

hazard. This is linked to the 'actors' in risk communication processes (as outlined in Rohrmann 1991).

Table 5

SAMPLING GROUPS OF RESPONDENTS -- Projects CRC & CRH

	"Western" countries			*"Eastern" countries*			*"Iberoamerican" countries*	
	Australia	Canada	Germany	China	Singapore	Japan	Brazil	
S t u d e n t s								*1184*
T-s Technology/Engineering	60	46	46	90	57	70	50	
G-s Geography	50	45	47	52	44	42	51	
P-s Psychology/Sociology	60	50	58	74	52	84	59	
S c i e n t i s t s								*171*
X-e Technical & Social Sciences	33	--	84	54	--	--	--	
Sum: N =	203	141	235	270	153	196	160	*1355*

In *Table 5* a set of samples is shown in which country sampling ("western", "eastern" and "ibero-american" countries) and social-group sampling (different students and scientists) is combined (cf. Rohrmann 2008, 2010). The findings presented in this article are mostly taken from those surveys.

2.5 Propositions re socio-psychological factors

How humans perceive and weigh up hazards for health and safety is influenced by manifold sociological and psychological factors. The conducted risk perception research reported here was based on the following propositions:

> Hazards are assessed according to the risk they present for people's life and health.

> Acceptance of risks is the outcome of weighing up negative outcomes and potential benefits of an action or technology.

> Emotional facets, such as fear associations, co-determine risk judgements.

> Attitudes, especially environmental concern and technology scepticism, influence most risk appraisals.

> Beliefs about risk acceptance differs for hazard types, such as technology-induced risks (e.g. chemical industry waste, air pollution) or natural hazards (e.g. earthquakes, floods).

> There are disparities between societal groups and professions, depending on their ideological orientations and social setting.

> Risk perception features vary across countries which differ in their developmental status and health and safety culture.

These propositions steered the design of the project, especially the design of the Hazard Evaluation Questionnaire (HEQ) and the sampling of survey participants.

3 PEOPLE'S JUDGMENTS OF HAZARDS

3.1 Viewpoints regarding hazard's risk level

Judgements about the riskiness of hazards have several aspects, including the assumed probability of dying, danger of health impacts, the catastrophic potential of a disaster, feelings of anxiety about risks, and an overall risk magnitude.rating. In *Table 6*, pertinent findings are presented in a table which integrates the results from studies in six countries. (results from the seventh country of this research project, Brazil, will be presented later in a separate chapter).

Within risky human activities, Smoking, Unsafe/unprotected sex and Halucinogenic drugs and working as an Underground miner get the highest and Car driving and Giving up a job surprisingly low ratings. The scores for fear associations are similar. Within dangers from residential and environmental hazards, Nuclear power plants and Air pollution are seen as largest hazards; a high catastrophic potential is also seen for earthquakes. The risks from Airports are least threatening.

The risk magnitude appraisals are not really in line with statistical data about the number of accidents and fatalities resulting from risk sources. For example, earthquakes or car crashes induce high numbers of deaths, coal power plants have more health-impairing impacts than nuclear power plants, and gambling harms millions of people financially - yet the pertinent risk ratings and safety worries seem to underestimate these hazards.

3.2 Appraisal of the acceptability of risk sources

The concept "risk acceptance" refers to statements about the acceptability of a risk in individual or societal terms, i.e., whether it is evaluated as being tolerable or not. *Principal* acceptability is the normative, and *actual* acceptance the empirical aspect. In strict terms "acceptance" would need to be based on a deliberate decision; however, if people do not choose or refuse a risk situation intentionally, defacto-acceptance results.

The acceptance judgements (cf. *Table* 6) are lowest for Drugs, Smoking, Unsafe sex and Thieve places, and highest for social occupations such as Firefighting, Giving up a meagre but secure job, and the never-ending Driving - in spite of the enormeous number of fatalies causes year by year by car traffic.

As expected, risks are more accepted if a hazardous action or technology provides benefits as well; this is especially the case with Firefighting, Cardriving, Cycling and Airports. For activities like Smoking, Unsafe sex, Hallucinogenic drugs and Gambling, some individual but almost no societal benefits are perceived.

If asked where the necessity of risk management is urgent, Drugs and environmental hazards like Floods and Hurricanes are main answers.

Table 6

JUDGMENTS OF HAZARDS - RESULTS FROM 6-COUNTRIES-STUDY

Project CRC
Six samples (Australia, Canada, China, Germany, Japan, Singapore) merged **(N=1024)**

Risk aspect:
RM = 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)
AA = Attractiveness of activity
IA = Individual risk acceptance
SA = Societal risk acceptance
NM = Necessity of risk management

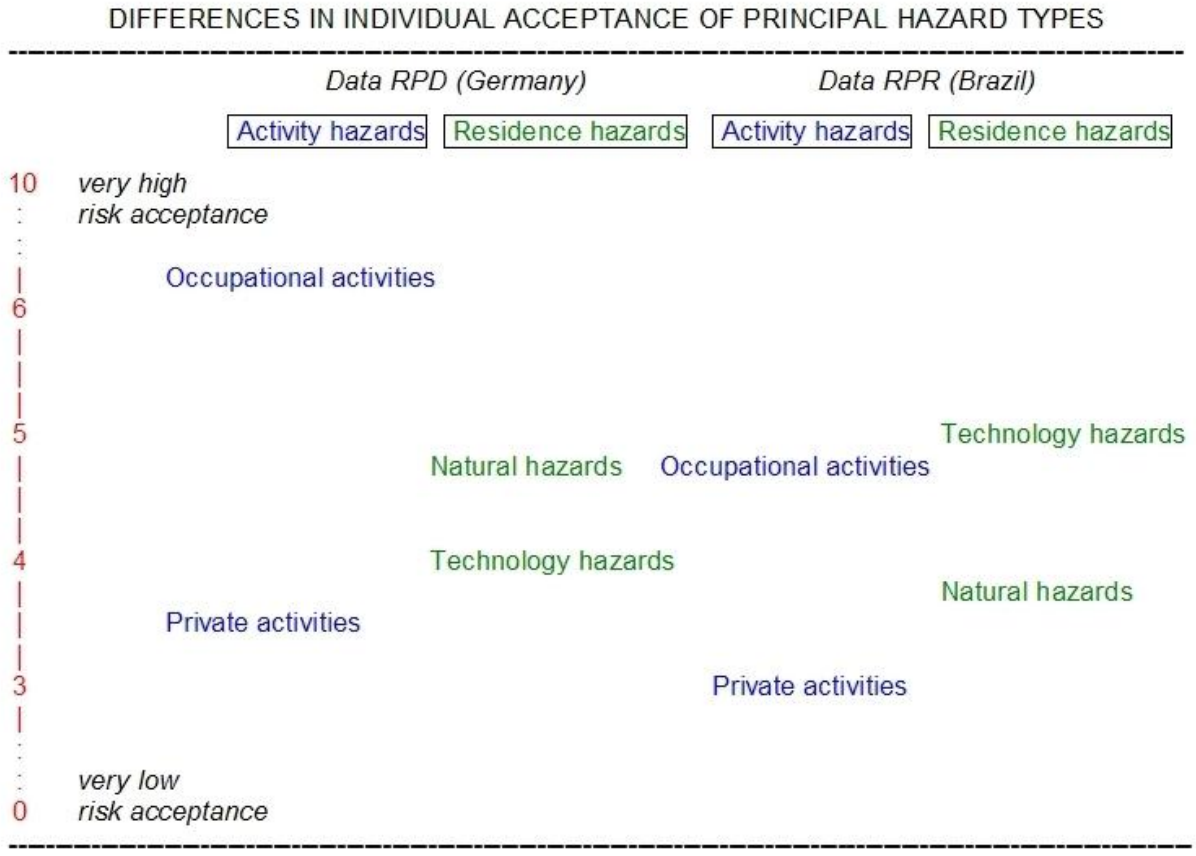
	RM	**PD**	**HI**	**CP**	**FA**	**IB**	**SB**	**AA**	**IA**	**SA**	**NM**	
↙ *Hazard*												
Z1	5.8	4.0	3.9		5.0	5.3	5.1	3.7	6.4	6.0	3.1	Cycling in urban traffic
Z2	4.1	3.8.	3.2		3.5	6.5	4.0	6.3	7.4	6.4	3.7	Regularly driving in cars
G	8.2	6.2	8.3		7.1	3.3	2.2	1.9	4.1	3.4	3.2	Longterm heavy smoking
J'	8.1	5.5	7.5		7.5	3.9	1.9	3.6	4.0	3.2	4.0	Unsafe/unprotected sex
I	6.5	4.8	7.2		5.6	3.9	2.7	3.9	5.0	4.2	2.9	Overeating
H'	8.3	6.8	8.1		7.8	4.1	1.6	3.4	3.7	2.8	5.1	Hallucinogenic drugs
K	5.8	4.7	4.8		5.7	6.0	8.3	4.8	6.7	7.8	2.3	Working as firefighter
L'	6.7	5.1	6.0		6.6	4.7	6.7	2.4	5.7	7.2	3.0	Work underground miner
$3	3.9	-/-	2.7	-/-	4.8	5.9	4.1	5.9	6.9	5.9	2.0	Giving up good&bad job
$1	6.1	-/-	3.7	-/-	5.7	4.7	2.6	4.1	4.7	3.8	2.5	Participating in gambling
$5	6.1	-/-	3.5	-/-	6.7	4.1	4.6	3.6	5.5	5.4	2.4	Uncertain investment
$2	5.7	-/-	3.7	-/-	6.5	4.3	-/-	2.2	3.6	3.1	-/-	Being in thieve places
R	6.5	5.0	3.8	7.7	6.5		-/-		5.5	5.6	4.2	Earthquake-prone area
Q'	6.7	5.0	4.0	6.9	6.5		-/-		5.3	5.4	4.2	Area prone to hurricanes
S'	6.6	4.6	3.9	6.4	6.3		-/-		5.2	5.4	4.9	Area with frequent floods
X'	6.9	4.2	7.0	6.3	6.4		-/-		4.2	5.5	4.9	Area w high air pollution
P	4.8	2.4	4.6	4.5	4.6		7.2		5.3	5.1	4.5	Large airport nearby
N	5.5	3.1	5.3	5.2	5.0		6.2		4.9	5.1	3.8	Coal power plant
U	7.0	4.2	5.7	7.7	6.9		5.9		4.2	4.3	4.5	Nuclear power plant
V	6.5	3.8	5.7	6.6	6.2		6.2		4.7	4.9	3.9	Chemical industry facilities
	6.2	*4.5*	*5.1*	*6.2*	*6.0*	*4.6*	*4.7*	*3.7*	*5.2*	*5.2*	*3.7*	*(Mean)*

Notes: *For full hazard names cf. table 3. Empty cells: variable not measured for activities or residential condition. Selected results; for complete table see Rohrmann 2003 & 2005.*

3.3 Influence of hazard types - risky activities and residential circumstances

As seen in *Table 6*, the acceptance of hazards varies considerably; furthermore, it matters what type of risk source is looked at. When merging single hazards into a typology, some trends become apparent; cf. *Figure 2,* where this is done for two of the seven country data sets.

Figure 2



It appears that risks resulting from occupational activites are principally more accepted than those stimulated by private behaviours. Regarding residential conditions, a recurrent finding is that technology-induced are evaluated as less accepted than natural hazards - mainly because they are seen as better avoidable. However, that is less true for developmental countries where technological progress is vital for evolution.

3.4 Subjective determinants of risk evaluations

Risk magnitude ratings and risk acceptance views, the two core aspects of risk perception, are both dependent on two kinds of factors: attributes of the hazard and socio-psychological features of the exposed people. In *Table 7,* three analyses are presented, to show how the significance of selected factors for acceptance judgments can be quantified.

The individual acceptance of the Car-driving risk is considerably influenced by assumed individual benefits, and risk propensity slightly increases acceptance. The benefit aspect is also substantial for the hazard Smoking, while risk attitudes are irrelevant in this case. Regarding a residental hazard, Living near chemical industry facilities, perceived risk magnitude and technology skepticism are essential factors for (non-)acceptance.

Many analyses like these multiple regressions, including causal structure modelling, were conducted in order to understand what is happening in people's mind when judging the riskiness of hazards. It turned out that risk perception can *not* be depicted as a simple configuration - it is a complex process.

Table 7

MULTIPLE REGRESSION ANALYSES FOR RISK ACCEPTANCE ASPECTS

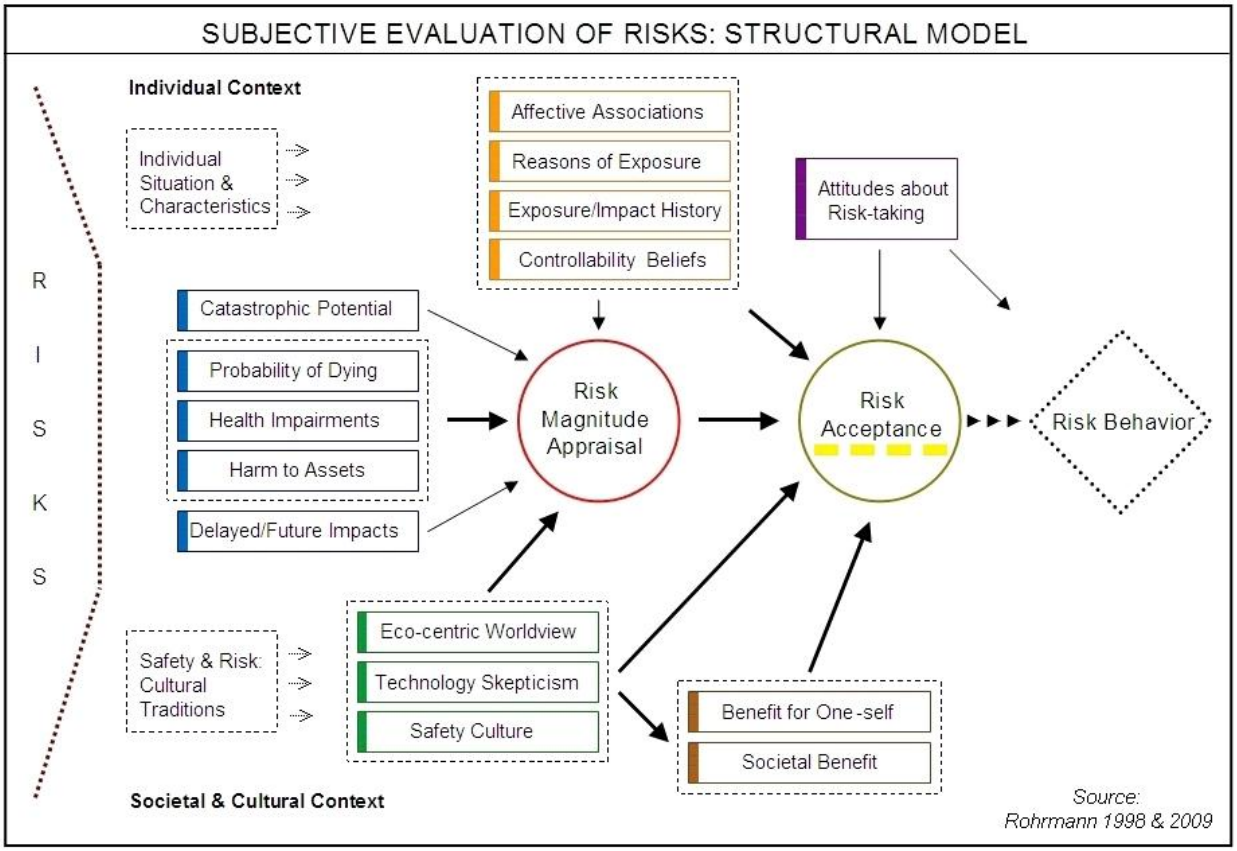
Data: Risk perception study in Recife/Brazil

Analysis for hazard:	**Regularly driving in cars**		**Long term heavy smoking**		**Living near chemical industry**	
Criterion = Dependent variable: **Individual acceptance of risk**						
Predictors = Independent variables ↓	*Beta*	*Corr P-C*	*Beta*	*Corr P-C*	*Beta*	*Corr P-C*
Overall risk magnitude rating	-.20	-.21	-.18	-.23	-.11	-.25
Feelings of anxiety about risk	-.15	-.23	-.08	-.12	-.23	-.30
Individual benefits	.42	.41	.33	.36	-/-	-/-
Attitude environmental concern	-/-	-/-	-/-	-/-	-.02	-.18
Attitude technology skepticism	-/-	-/-	-/-	-/-	-.26	-.31
Risk propensity attitude	.14	.20	.04	.04	-/-	-/-
Risk aversion attitude	.06	-.03	-.05	-.15	-/-	-/-
R	.52		.42		.43	
R^2 (adjusted)	.27		.18		.18	
Significance	**		**		**	

Notes: *Beta = beta-weight of predictor; Corr P-C = correlation of predictor with criterion.*

The conceptual model shown in *Figure 3* reveals the multiple influences which affect responses to risk exposure (source: Rohrmann 1998 & 2003).

Fig 3:



The principal message of this model is that neither perceived risk magnitude nor acceptance of risks can be sufficiently explained by quantitative features such as event probabilities or expected damage. Emotional links to risk situations, opinions regarding environment and technology and attitudes like risk propensity all play a role in this process, which is embedded in the health & safety culture of a society. However, based on their knowledge, personality and social environment, each individual may develop a personal influence pattern for the relevance of the factors embodied in this model. Consequently, risk evaluations vary to a great extent across countries and cultures.

4 RECENT RESEARCH: RESULTS FROM AN IBERO-AMERICAN STUDY

Initial remark:
This first risk perception study completed in 'Ibero-America' became possible because the data collection in Recife/Brasil by Bernd Rohrmann was enabled by Klaus Eichner. They jointly analyzed the achieved results and prepared this article - yet a few months ago Eichner passed away. Thus the following sections were elaborated by Rohrmann.

4.1 Appraisal of Brazilian hazards

The judgements of the Brazilian students about the magnitude of risks vary considerably across hazard types. As the data in *Table 8* confirm, the most negative ratings are for Long-term smoking, Unsafe/unprotected sex and Consuming hallucinogenic drugs. The ratings for residential and environmental conditions are less high. Given the dangerous traffic situation, Regularly car driving ranks astoundingly low.

The assumed Catastrophic potential is higher for natural hazards (such as landslides) than technological hazards (such as Nuclear power). Interestingly, most feared is Living in a high-crime area.

4.2 Accepted versus not-accepted risk sources

Out of the evaluated 25 risk sources, least accepted are Consuming hallucinogenic drugs and Having unsafe/unprotected sex - see *Table 9*. Even the acceptance of (widely common) Smoking is quite restricted. In societal terms the ratings are slightly less negative but still low.

Acceptance is highest for Car driving, and reasonably high for Airports. This is linked to attributed benefits, which are strongest for Car driving. When asked about the necessity of risk management (rating "NM"), High-crime areas are the dominant choice.

4.3 Differences among student groups

A selection of subgroup differences are presented in *Table 10.* Some disparities are significant, for example, Technology students worry less about Car driving or Airports or Nuclear power plants than Geography or Social-Science students.

Altogether significant differences are rare. This also applies to the degree of personal risk exposure (rating RP) - which seems to underestimate the actual link to many hazards in people's life.

Table 8

JUDGMENTS OF RISKINESS OF HAZARDS

***Project CRH = Cognition of risks from hazards* - Recife/Brazil sample (N=160)**

Risk aspect:

RM = Overall risk magnitude rating
PD = (Assumed) Probability of dying
HI = (Danger of) Health impacts
EI = Economic/financial impacts
CP = Catastrophic potential
FA = Feelings of anxiety about risk

	RM	**PD**	**HI**	**EI**	**CP**	**FA**	
Hazard:							
Z2	4.7	4.8	4.0	-/-	-/-	3.9	Regularly driving in cars
G	8.9	7.6	9.1	-/-	-/-	5.6	Long-term heavy smoking
J'	9.0	6.9	8.7	-/-	-/-	6.9	Having unsafe/unprotected sex
I	8.0	6.6	8.3	-/-	-/-	5.7	Eating too much and very fatty food
H'	8.6	7.8	8.7	-/-	-/-	6.8	Consuming hallucinogenic drugs
E	6.9	4.8	8.4	-/-	-/-	4.5	Working in an X-ray laboratory
L'	7.7	5.9	7.1	-/-	-/-	5.8	Working underground as a miner
A’	5.4	4.5	4.7	-/-	-/-	5.0	Partaking in high impact sports
D’	7.7	5.8	7.0	-/-	-/-	5.3	Working with toxic materials
Z3	4.0	2.6	3.7	-/-	-/-	2.5	Regularly using a mobile phone
Z6	6.9	6.3	5.7	-/-	-/-	6.3	Travelling in an unsafe country
$3	8.0	7.5	6.7	-/-	-/-	8.2	Giving up meagre but secure job
$1	5.0	-/-	-/-	7.4	-/-	6.2	Regularly participating in gambling
$2	6.2	-/-	-/-	8.5	-/-	6.5	Being in places where thieves are
$5	6.7	-/-	-/-	7.5	-/-	6.9	Investing in an uncertain product
$7	8.4	8.3	6.5	8.2	8.2	8.7	Living in a high-crime area
R	7.0	6.8	5.3	7.9	7.8	7.1	Living in earthquake-prone area
Q'	7.3	6.9	5.3	8.0	7.8	7.2	Area prone to hurricanes
S'	7.5	6.5	6.7	8.2	7.2	7.5	Area with frequent floods
X'	7.2	5.2	8.0	5.3	6.2	5.8	Area with high air pollution
P	4.8	3.3	4.7	4.3	5.3	4.3	Large airport nearby
N	4.5	3.3	6.7	4.1	5.6	4.5	Coal power plant
U	6.8	5.2	6.4	5.3	7.5	6.7	Nuclear power plant
V	6.5	5.1	6.6	5.1	7.0	6.3	Chemical industry facilities
Z7	7.9	7.3	6.0	8.3	7.2	7.8	Area where there are landslides
	6.9	*5.9*	*6.5*	*6.8*	*7.0*	*6.1*	*(Mean)*

Rating scale: "0" to "10". For full hazard names cf. table 3.
Cells -/-: Risk aspect not applicable for these activities or residential conditions.

p.t.o.!

Table 9

ACCEPTANCE RATINGS FOR HAZARDS

***Project CRH = Cognition of risks from hazards* - Recife/Brazil sample (N=160)**

Risk aspect:

IB = Individual benefit (of activity)
SB = Societal benefit (of activity)
AA = Attractiveness of activity
IA = Individual risk acceptance
SA = Societal risk acceptance
NM = Necessity risk management

	IB	**SB**	**AA**	**IA**	**SA**	**NM**	
Hazard:							
Z2	7.5	5.2	6.9	7.7	7.4	6.0	Regularly driving in cars
G	2.3	1.4	2.5	2.9	3.8	7.4	Long-term heavy smoking
J'	2.8	1.8	4.2	2.8	3.3	7.8	Having unsafe/unprotected sex
I	3.2	1.9	4.8	3.8	4.3	6.7	Eating too much and very fatty food
H'	2.4	1.6	3.0	2.3	2.8	7.9	Consuming hallucinogenic drugs
E	3.7	4.4	2.4	5.0	6.1	6.0	Working in an X-ray laboratory
L'	2.8	4.1	1.9	4.3	5.5	7.1	Working underground as a miner
A’	6.4	4.3	7.0	6.7	6.7	3.8	Partaking in high impact sports
D’	3.0	3.9	2.1	4.5	5.5	7.0	Working with toxic materials
Z3	6.6	5.1	6.4	7.5	7.7	3.6	Regularly using a mobile phone
Z6	3.5	3.3	3.8	4.5	4.7	5.3	Travelling in an unsafe country
$3	2.0	2.2	1.6	2.5	3.0	8.8	Giving up meagre but secure job
$1	5.2	4.0	5.0	5.3	4.5	3.3	Regularly participating in gambling
$2	3.1	1.8	3.2	3.4	3.8	5.6	Being in places where thieves are
$5	3.7	3.5	3.2	4.0	4.5	4.3	Investing in an uncertain product
$7	-/-	-/-	-/-	2.4	2.9	9.3	Living in a high-crime area
R	-/-	-/-	-/-	4.2	4.5	8.3	Living in earthquake-prone area
Q'	-/-	-/-	-/-	4.0	4.5	8.3	Area prone to hurricanes
S'	-/-	-/-	-/-	3.2	3.6	8.8	Area with frequent floods
X'	-/-	-/-	-/-	3.9	4.7	8.5	Area with high air pollution
P	-/-	7.4	-/-	6.2	6.5	6.6	Large airport nearby
N	-/-	4.5	-/-	5.7	5.8	6.8	Coal power plant
U	-/-	5.3	-/-	3.8	4.5	8.3	Nuclear power plant
V	-/-	6.1	-/-	4.2	4.7	8.0	Chemical industry facilities
Z7	-/-	-/-	-/-	3.0	3.5	8.9	Area where there are landslides
	3.9	*3.8*	*3.9*	*4.3*	*4.7*	*6.9*	*(Mean)*

Rating scale: "0" to "10".
Cells with "-/-": Risk aspect not applicable for these activities or residential conditions.

4.4 Comparison of Brazilian, German and Australian risk ratings

In *Table 11*, for three countries of special interest the differences in essential risk ratings are presented. This comparison is restricted to 10 hazards.

Table 10

HAZARD RATINGS BY DIFFERENT GROUPS OF STUDENTS

Research project "CRH" = Cognition of risks from hazards **Recife/Brazil sample RPR (N=160)**

Comparison of main data set and subgroup samples

[a] Recife data - Full sample (N=160) [b] Recife data - Social Subgroup (N=59)
[c] Recife data - Geography Subgroup (N=51) [d] Recife data - Technical Subgroup (N=50)

Risk Aspect

RM = Overall risk magnitude rating
PD = (Assumed) Probability of dying
HI = (Danger of) Health impacts
EI = Economic/financial impacts
CP = Catastrophic potential
FA = Feelings of anxiety about risk
IB = Individual benefit (of activity)
SB = Societal benefit (of activity)
AA = Attractiveness of activity
IA = Individual risk acceptance
SA = Societal risk acceptance
NM = Necessity of risk mgmt
PR = Personal relation to risk source

	RM	PD	HI	EI	CP	FA	IB	SB	AA	IA	SA	NM	PR	
Hazard:														
Z2-a	4.7	4.8	4.0	-/-	-/-	3.9**	7.5	5.2	6.9	7.7**	7.4	6.0	1.1	Car driving
-b	4.7	4.7	4.2	-/-	-/-	4.3	7.2	5.1	6.7	7.2	7.1	6.1	1.0	
-c	4.7	5.4	4.4	-/-	-/-	4.3	7.3	4.8	6.9	7.8	7.6	5.9	0.8	
-d	4.8	4.4	3.6	-/-	-/-	3.0	8.1	5.7	7.0	8.2	7.7	6.0	1.6	
G-a	8.9	7.6**	9.1	-/-	-/-	5.6	2.3	1.4	2.5	2.9	3.8	7.4	0.4	Smoking
-b	8.2	6.8	8.6	-/-	-/-	6.1	2.7	1.6	2.9	3.6	4.5	7.2	0.4	
-c	9.4	8.4	9.4	-/-	-/-	5.4	1.8	1.5	2.1	2.3	3.1	7.3	0.5	
-d	9.4	7.6	9.4	-/-	-/-	5.1	2.3	1.2	2.3	2.8	3.8	7.9	0.4	
J'-a	9.0	6.9	8.7	-/-	-/-	6.9	2.8	1.8	4.2	2.8**	3.3	7.8	0.5	Unsafe sex
-b	8.8	6.1	8.2	-/-	-/-	7.5	3.0	1.8	4.2	3.3	3.8	7.5	0.6	
-c	9.3	7.9	9.1	-/-	-/-	6.3	2.2	1.8	3.4	1.8	2.5	7.5	0.5	
-d	8.9	6.7	8.8	-/-	-/-	6.6	3.3	1.7	4.9	3.2	3.7	8.6	0.5	
P-a	4.8	3.3	4.7	4.3	5.3**	4.3	-/-	7.4	-/-	6.2	6.5	6.6**	0.7	Airport
-b	5.0	3.6	5.3	5.0	6.2	4.9	-/-	7.5	-/-	6.1	6.4	7.4	0.8	
-c	4.6	3.4	4.2	4.2	5.3	4.3	-/-	7.3	-/-	6.2	6.3	6.9	0.5	
-d	4.6	2.8	4.4	3.6	4.1	3.7	-/-	7.4	-/-	6.1	6.7	5.6	0.6	
U-a	6.8	5.2	6.4	5.3	7.5**	6.7**	-/-	5.3	-/-	3.8	4.5	8.3	0.1	Nuclear powerplant
-b	7.2	5.1	6.3	5.9	8.3	7.6	-/-	4.9	-/-	3.3	4.0	8.8	0.1	
-c	6.6	6.0	7.0	5.3	7.5	6.8	-/-	5.2	-/-	3.9	4.6	8.4	0.1	
-d	6.4	4.6	5.9	4.6	6.6	5.5	-/-	5.9	-/-	4.3	4.8	7.7	0.1	
{a}	*6.9*	*5.9*	*6.5*	*6.8*	*7.0*	*6.1*	*3.9*	*3.8*	*3.9*	*4.3*	*4.7*	*6.9*	*0.6*	*(Mean)*
{b}	*6.8*	*5.7*	*6.4*	*7.0*	*7.5*	*6.8*	*4.1*	*3.7*	*4.0*	*4.3*	*4.8*	*7.0*	*0.6*	
{c}	*7.0*	*6.3*	*6.4*	*7.0*	*6.9*	*6.0*	*3.3*	*3.7*	*3.6*	*4.1*	*4.5*	*7.0*	*0.6*	
{d}	*6.8*	*5.6*	*6.1*	*6.3*	*6.4*	*5.3*	*4.3*	*3.9*	*4.0*	*4.4*	*4.9*	*6.6*	*0.6*	

NOTES:
Empty cells: variable not measured for activities or residential condition.
*Subgroup disparities: "**" is added if difference is significant on 1% level.*

Table 11

RISK APPRAISALS IN DIFFERENT COUNTRIES

Selected data from 3 samples: Australa (N=170), Germany (N=151), Brazil (N=160)

Risk aspect:

RM = Overall risk magnitude rating **FA** = Feelings of anxiety about risk **IA** = Individual risk acceptance

Data:	***Aus***	***Ger***	***Braz***	***Aus***	***Ger***	***Braz***	***Aus***	***Ger***	***Braz***	
Hazard:										
Z2	4.0	4.4	4.7	3.3	2.9	3.9	7.9	6.5	7.7	Regularly driving in cars
G	8.8	8.4	8.9	7.8	7.1	5.6	4.8	3.4	2.9	Long-term heavy smoking
J'	8.2	7.8	9.0	7.7	7.4	6.9	5.0	3.3	2.8	Having unsafe/unprotected sex
I	6.5	7.2	8.0	5.7	5.5	5.7	5.7	4.9	3.8	Eating too much & very fatty food
H'	7.7	8.0	8.6	7.4	7.3	6.8	5.0	3.4	2.3	Consuming hallucinogenic drugs
$1	5.8	4.3	6.4	6.0	2.7	6.2	5.8	5.5	3.3	Regular participation gambling
S'	6.2	6.3	7.5	5.6	5.8	7.5	6.2	4.7	3.2	Area with frequent floods
P	4.2	5.2	4.8	4.2	4.3	4.3	6.0	4.5	6.2	Large airport nearby
N	5.3	5.0	4.5	4.8	4.3	4.5	5.4	4.6	5.7	Coal power plant
U	7.1	6.5	6.8	7.3	7.5	6.7	4.6	3.5	3.8	Nuclear power plant
	6.2	*5.9*	*6.9*	*5.9*	*5.2*	*6.1*	*5.9*	*5.6*	*4.6*	*(Mean, based on all hazards)*

Rating scale: "0" to "10". For full hazard names cf. table 3.
The above country differences are significant, mostly on 1% or 5% level.

Characteristics of the Brazilian sample: High risk rating and very low acceptance of Having unsafe/unprotected sex and Consuming hallucinogenic drugs. Characteristics of the German sample: Low acceptance of Airports and Nuclear power plants. Characteristics of the Australian sample: Lowest worry and highest acceptance regarding Car driving, Eating too much and Gambling. Nonetheless, the overall rank order across all hazards is not overly different for these three countries.

Eventually, such comparisons need to be interpreted with care, because nations outside Europe, like Australia and even more so Brazil, incorporate an enormous ethnological and sociological diversity (Eichner & Rohrmann 2012, Rohrmann 1994, Sjoeberg 1999) - thus, group differences may be more influential than country differences.

5 CONCLUSIONS

5.1 Interpreting risk perception studies

When analyzing how people observe and evaluate risks in their environment, multiple factors require deliberation - ranging from physical hazard facets to psychological and sociological features. The model in Fig 3 (above) tries to present the structure of core aspects. Most current 'ad hoc' judgements are rooted in long-established habits and norms

(Eichner 1991, Weber & Hsee 2000), and significantly shaped by social contexts (cf. e.g. Renn 2010, Sjoeberg 1999). Furthermore, humans are not "machines", meaning, that 'objective' informations and 'subjective' affects are always intertwined (Finucane & Holup 2006, Sjoeberg 2006). Risks are complex situations, and rational decisions about them (Dieckmann et al 2008, Rohrmann & Renn 2000, Wardman 2006) are truly demanding.

For almost all people the available knowledge is restricted, and decision processes are not standardized anyway. Indeed, each individual may have a personal influence pattern for the relevance of variables covered in the above process model. This begins with the intuitive risk definition a person employs and ends with the importance of societal attitudes not specific to the risk source.

In sum, risk perceptions are interpretations of the world, based on experiences and/or beliefs. They are embedded in the norms, value systems and cultural idiosyncrasies of societies, and therefore vary across groups and countries.

5.2 Impacts of country and of group disparities

Risk perceptions have a crucial impact on people's risk attitudes and risk behaviour (Rohrmann 2008). Therefore both group features and country features should be carefully considered when designing and executing risk communication and emergency management programs (Fischhoff et al 1997, Rohrmann 2009, Wiedemann & Schuetz 2010). Risk information has two different tasks - on one hand, to make people aware of hazard and their implications, and on the other hand, to counterbalance unnecessary worries. Disaster preparation aims at protecting people at risk. These agendas need to reflect that the effectiveness of procedures always differs socially.

Table 12

UTILITY OF RISK PERCEPTION RESEARCH
Findings about socio-psychological risk perception processes are relevant for > analyzing discrepancies between statistical risk data and subjective judgments > understanding the influence of professional and societal orientations ('worldviews') > separating differences between countries and those amongst social groups > expounding why various people underrate or ignore existing hazards > clarifying the roots of controversies about risky technologies > identifying core needs for risk communication and disaster preparedness programs > designing risk information in line with people's thinking about hazards > recognizing reasons for shortcomings of safety campaigns > considering cultural differences in conceptualizing and conducting risk communication

5.3 Considerations for future research

After this study, and the many related surveys in other countries, the gained knowledge about "perception of hazards for health and safety" is extensive. In *Table 12* a summary of valuable research outcomes is outlined.

However, given how essential risk perception factors are for risk communication and risk management, and how diverse viewpoints are in multifaceted societies, there is still a need for ongoing research. This includes to look at more subgroups of societies. One crucial issue is to fully understand how people translate their appraisal of a present hazard into a decision about what to do and what not to do, and how to act to avoid or at least reduce a risk - thus an investigation should connect risk perception and risk behavior. Furthermore, some specific cultures, such as Islam, as well as some types of countries, such as Africa, have only marginally been investigated.

Finally, the increasingly cross-cultural nature of risk perception research - providing knowledge about universal *and* culture-specific factors of subjective risk evaluations - is genuinely valuable in a world where more people than ever are exposed to physical and social hazards.

REFERENCES

Baghal, T., 2011, The measurement of risk perceptions: the case of smoking, Journal of Risk Research, 14, 351-361.

Beck, U., 1992, Risk Society: Towards a new modernity, London: Sage.

Chauvin, B., Hermand, D. & Mullet, E., 2007, Risk perception and personality facets, Risk Analysis, 27, 171-185.

Dake, K., 1992, Myths of nature: Culture and the social construction of risk, Journal of Social issues, 48, 21-37.

Diekmann, A., Eichner, K., Schmidt, P. & Voss, T., 2008, Rational choice: Theoretische Analysen und empirische Resultate, Wiesbaden, Verlaf fuer Sozialwissenschaften.

Eichner, K., 1991, Die Entstehung sozialer Normen, Opladen: Westdeutscher Verlag.

Eichner, K. & Rohrmann, B., 2012 *in prep.:* People's awareness and appraisal of hazards: a risk perception study in Brazil. *To be submitted to the Brazilian Journal Estudos de Sociologia (in Portugese)*.

Finucane, M. L. & Holup, J. L., 2006, Risk as value: Combining affect and analysis in risk judgements, Journal of Risk Research, 9, 141.

Fischhoff, B., Bostrom, A. & Quadrel, M. J., 1997, Risk perception and communication. In: R. Detels, J. McEwen & G. Omenn (Eds.), Oxford textbook of public health, 987-1002, London, Oxford University Press.

Fischhoff, B., Lichtenstein, S., Slovic, P., Derby, S. L. & Keeney, R. L., 1982, Acceptable risk, Cambridge: University Press.

Kasperson, R. E., Renn, O., Slovic, P. & Halina, S., 1988, The social amplification of risk: a conceptual framework, Risk Analysis, 177-187.

Rayner, S., 1992, Cultural theory and risk analysis. In: S. Krimsky & D. Golding (Eds.), Social theories of risk, Westport: Praeger.

Renn, O., 1992, Concepts of Risk: A classification. In: S. Krimsky & D. Golding (Eds.), Social theories of risk, 53-82, London: Praeger.

Renn, O., 2010, Sicherheit, Risiko und Vertrauen. In: P. Winter, E. Schnieder & F.W. Bach (Eds.), Sicherheitsforschung - Chancen und Perspektiven, 163-184, Heidelberg, Springer.

Rohrmann, B., 1991, Akteure der Risiko-Kommunikation. In: H. Jungermann, B. Rohrmann & P. M. Wiedemann (Eds.), Risikokontroversen: Konzepte, Konflikte, Kommunikation, 355-371, Berlin etc.: Springer.

Rohrmann, B., 1994, Risk perception of different societal groups: Australian findings and cross-national comparisons, Australian Journal of Psychology, 46, 150-163.

Rohrmann, B., 1998, The risk notion: Epistemological and empirical considerations. In: M. G. Steward & R. E. Melchers (Eds.), Integrated risk assessment: Applications and regulations, 39-46, Rotterdam, Balkama.

Rohrmann, B., 2000, Cross-cultural studies on the perception and evaluation of hazards. In: O. Renn & B. Rohrmann (Eds.), Cross-cultural risk perception: A survey of empirical studies, 103-144, Dordrecht, Kluwer Academic Publishers.

Rohrmann, B., 2003, Perception of risk: Research, results, relevance. In: J. Gough (Ed.), Sharing the future - Risk communication in practice, 21-44, Christchurch, CAE, University of Canterbury.

Rohrmann, B., 2006, Cross-cultural comparison of risk perceptions: Research, results, relevance. Contribution to the ACERA&SRA conference.
Available via www.acera.unimelb.edu.au/sra/SRA2006.html.

Rohrmann, B., 2008, Risk perception, risk attitude, risk communication, risk management: A conceptual appraisal. In: The International Emergency Management Society (Ed.), Global co-operation in emergency and disaster management - 15th TIEMS Conference, Prague/Czechia.

Rohrmann, B., 2009, Implications of people's risk perception for conceptualizing emergency preparedness. In: N. K. Rosmueller (Ed.), Proceedings of the 16th TIEMS Annual Conference "Lets meet where the continents meet", Istanbul/Turkey, 362-369, The International Emergency Management Society.

Rohrmann, B., 2010, Comparisons of risk perception in different countries and cultures - Project information. *Available via www.rohrmannresearch.net/rpx.htm*.

Rohrmann, B. & Renn, O., 2000, Risk perception research - An introduction. In: O. Renn & B. Rohrmann (Eds.), Cross-cultural risk perception: A survey of empirical studies, 11-54, Dordrecht, Kluwer Academic Publishers.

Sjoeberg, L., 1999, World views, political attitudes and risk perception, Risk - Health, Safety and Environment, 9, 137-152.

Sjoeberg, L., 2006, Rational risk perception: Utopia or dystopia?, Journal of Risk Research, 9, 683-696.

Slovic, P., 1992, Perception of risk: Reflections on the psychometric paradigm. In: D. Golding & S. Krimsky (Eds.), Theories of risk, 117-152, London: Praeger.

Slovic, P., 2000, The perception of risk, London, Earthscan.

Wardman, J. K., 2006, Toward a critical discourse on affect and risk perception, Journal of Risk Research, 9, 109.

Weber, E. U. & Hsee, C. K., 2000, Culture and individual judgment and decision making, Applied Psychology: An International Review, 49, 32-61.

Wiedemann, P. M. & Schuetz, H., 2010, Risikokommunikation als Aufklaerung: Informieren ueber und Erklaeren von Risiken. In: V. Linneweber, E.D. Lantermann & E. Kals (Eds.), Enzyklopaedie der Psychologie, 793-827, Goettingen, Hogrefe.

Willis, H. H. & Dekay, M. L., 2007, The roles of group membership, beliefs, and norms in ecological risk perception, Risk Analysis, 27, 1365-1380.

[]