

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

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REFERENCES

Two assertions by Bernd Rohrmann -- July 2013

Firstly, I could not finish this article together with my colleague and friend Klaus Eichner because he was quite ill and passed away in October 2012. Backed by the journal, I completed it on my own, covering his sociological considerations with sincerity.

Furthermore, in May 2013 the journal's chief editor, Werner Habermehl, unexpectedly died. He had been ailing for a while, and thus he could not deal with the article I submitted. Moreover, the future of the Journal is at risk - most likely it will cease.

Consequently I have opted to add this text to my "RohrmannResearch" website; its publication in a journal is to be decided at a later stage.

Perception of hazards for health and safety: Crosscultural 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 interdisziplinären Gebiet untersuchen Psychologen, Soziologen und Politikwissenschaftler, wie Menschen Gefahrenquellen einschätzen und bewerten, die im beruflichen oder privaten Leben auftreten, mit technologischen Entwicklungen einhergehen, im Wohngebiet gegeben sind oder auf Umweltveränderungen bezogen sind. In diesem Aufsatz werden zunächst die zugrundeliegenden Konzepte und Untersuchungsansätze erläutert und dann wichtige Ergebnisse aus Forschung in mehreren Ländern dargestellt. Ein spezieller Abschnitt gilt Resultaten aus einer neuen Studie die in Brasilien durchgeführt wurde. Zusammengefasst, Risiko-Perzeption ist eine Interpretation von Gefahrenquellen, die auf deren Auftreten, persönlichen 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 dafür, 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".

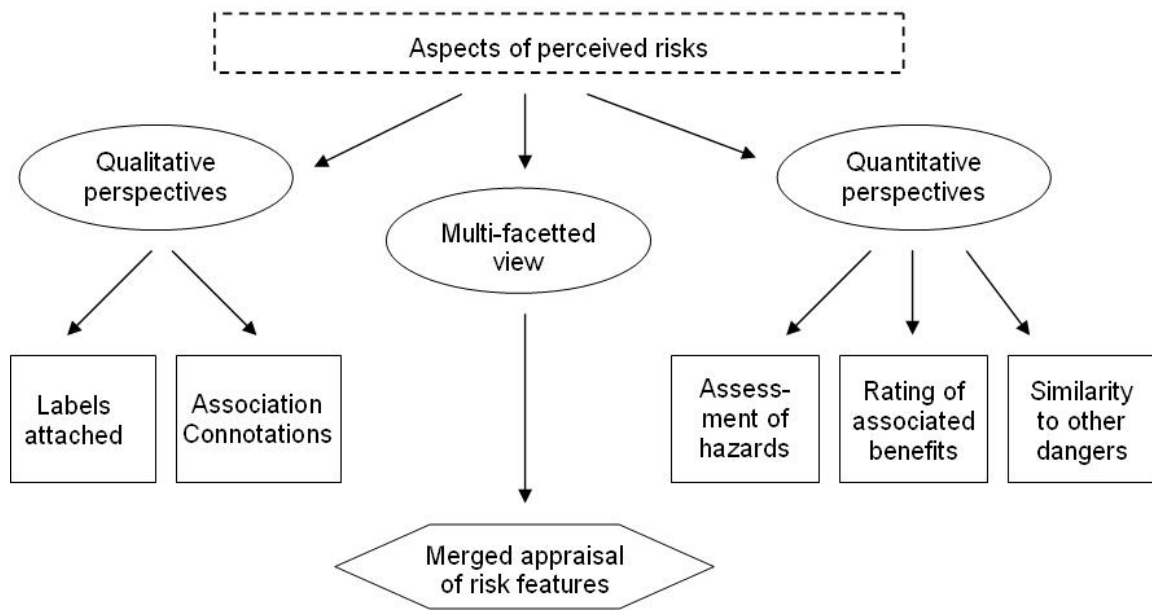
Main issues are the cognitive structure of risk ratings, subjective concepts underlying risk judgments, the determinants of perceived risk magnitude and risk acceptance, and differences between societal groups or countries and cultures (cf., e.g., Finucane & Holup 2006, Fischhoff et al. 1982, Fischhoff et al. 1997, Rohrman 2003, Rohrman 2006, Rohrman & Renn 2000, Sjoeborg 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	<i>intra-national</i>	<i>inter-national</i>
<i>Units of study</i>	professional or ideological sub-groups of society	countries or cultures
<i>Core variables</i>	beliefs & 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, Rohrman & Renn 2000, Sjoeborg 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 Rohrman (cf. Rohrman 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			
<i>FACET</i>	<i>Included:</i>	<i>Conceptual basis:</i>	<i>Example:</i>
<i>Hazards:</i>	24 risk sources	hazard taxonomy	earthquake
<i>Risk features:</i>	12 evaluation aspects	causal model of risk perception	rated magnitude
<i>Respondents:</i>	(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

<i>Individual activities</i>	Regularly participating in gambling
Regularly driving in cars	Investing in an uncertain product/new firm
Regularly partaking in high impact sports	<i>Residential conditions</i>
Long-term heavy smoking	Living in an earthquake-prone area
Having unsafe/unprotected sex	Living in an area prone to storms/hurricanes
Eating too much and very fatty food	Living in an area where there are landslides
Consuming hallucinogenic drugs	Living in an area with frequent floods
Working in an X-ray laboratory	Living in an area with high air pollution
Working with toxic materials	Living near a large airport
Working underground as a miner	Living near a coal power plant
Regularly using a mobile phone	Living near a nuclear power plant
Travelling in a unstable and unsafe country	Living near chemical industry facilities
Being in places where thieves operate	Living in a high-crime area
Giving up a dissatisfactory but secure job	

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	SB Societal benefits
PD Probability of dying	IB Individual benefits
HI Danger of health impacts	AA Attractiveness of activity
EI Economic impacts	SA Societal acceptance of risk
CP Catastrophic potential	IA Individual acceptance of risk
FA Feelings of anxiety	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, Sjoeborg 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 Rohrman 1991).

Table 5

SAMPLING GROUPS OF RESPONDENTS -- Projects CRC & CRH								
	<i>"Western"</i> <i>countries</i>			<i>"Eastern"</i> <i>countries</i>		<i>"Iberoamerican"</i> <i>countries</i>		
	Australia	Canada	Germany	China	Singapore	Japan	Brazil	
<i>Students</i>								<i>1184</i>
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	
<i>Scientists</i>								<i>171</i>
X-e Technical & Social Sciences	33	--	84	54	--	--	--	
Sum: N =	203	141	235	270	153	196	160	<i>1355</i>

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. Rohrman 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 Hallucinogenic 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 enormous number of fatalities 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.

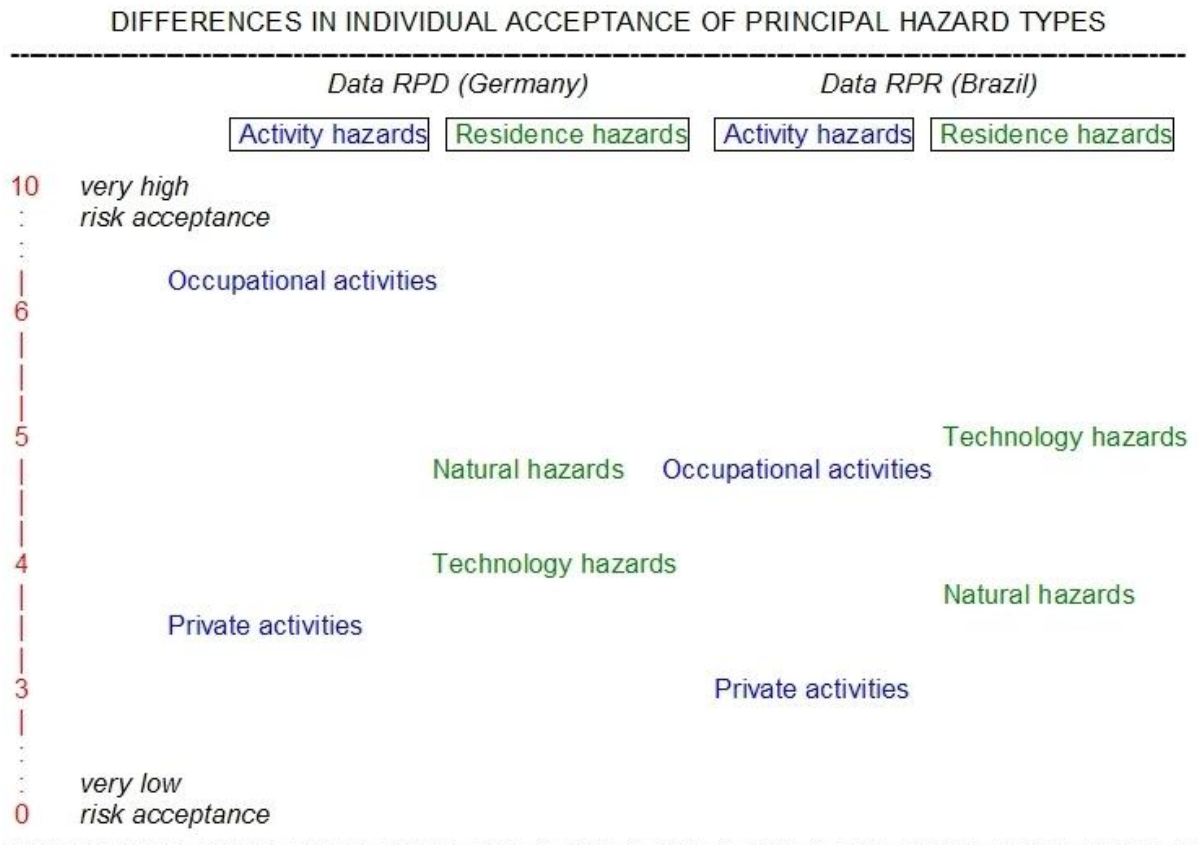
If asked where the necessity of risk management is urgent, Drugs and environmental hazards like Floods and Hurricanes are main answers.

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 activities 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 residential 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.

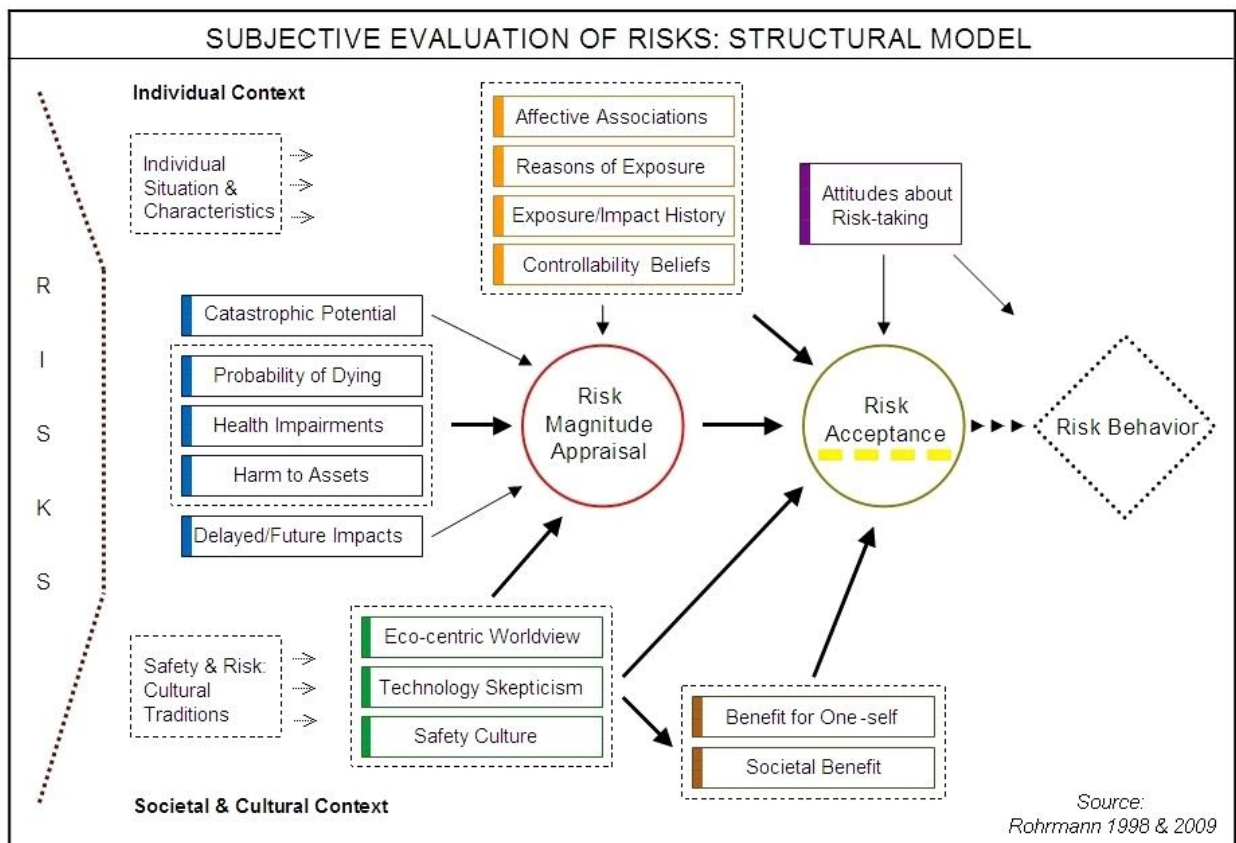
Table 7

MULTIPLE REGRESSION ANALYSES FOR RISK ACCEPTANCE ASPECTS							
<i>Data: Risk perception study in Recife/Brazil</i>							
<i>Analysis for hazard:</i>		Regularly driving in cars		Long term heavy smoking		Living near chemical industry	
<i>Criterion = Dependent variable:</i> Individual acceptance of risk							
<i>Predictors = Independent variables</i>	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	-/-	-/-	
<i>R</i>	.52		.42		.43		
<i>R</i> ² (adjusted)	.27		.18		.18		
<i>Significance</i>	**		**		**		

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							
<i>Project CRH = Cognition of risks from hazards - Recife/Brazil sample (N=160)</i>							
<i>Risk aspect:</i>							
	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		
<i>Hazard:</i>							
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							
<i>Project CRH = Cognition of risks from hazards - Recife/Brazil sample (N=160)</i>							
<i>Risk aspect:</i>							
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		
<i>Hazard:</i>							
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)
<i>Rating scale: "0" to "10".</i>							
<i>Cells with "-/-": Risk aspect not applicable for these activities or residential conditions.</i>							

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: Australia (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:

	Aus	Ger	Braz	Aus	Ger	Braz	Aus	Ger	Braz	
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	<i>(Mean, based on all hazards)</i>

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 & Rohrman 2012, Rohrman 1994, Sjoeborg 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, Sjöberg 1999). Furthermore, humans are not "machines", meaning, that 'objective' informations and 'subjective' affects are always intertwined (Finucane & Holup 2006, Sjöberg 2006). Risks are complex situations, and rational decisions about them (Dieckmann et al 2008, Rohrman & 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 (Rohrman 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, Rohrman 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
<p>Findings about socio-psychological risk perception processes are relevant for</p> <ul style="list-style-type: none"> > 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.

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