Investigating risk perception: a short introduction

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Introduction

Risk is always the risk of something (technical facility, natural hazard) to someone (an individual, a group of people, society or all humankind). Moreover, that risk is perceived not solely by technical parameters and probabilistic numbers, but in our psychological, social and cultural context. Individual and social characteristics form our risk perception and influence the way we react towards risks. Our risk perception is attenuated or amplified in a typical pattern described by the psychometric paradigma (Slovic 1987). These characteristics must be taken into account in dealing and working with risk or risky human activities or natural events.

It is useful to understand the "soft facts" that, especially in case of lay people, outdo the "hard facts" such as technical or medical expertise (WBGU 1998). Experts typically define risk strictly in terms of annual mortalities. Lay people almost always include other factors in their definition of risk, such as catastrophic potential, equity (i.e. whether those receiving benefits from the technology bear their share of risks), effects on future generations, controllability and involuntariness. These differing conceptions often result in lay people assigning relatively little weight to risk assessments conducted by technical experts or government officials (Covello et al. 1987). This does not mean that lay people are not aware of or badly estimate annual fatalities. The opposite is true: lay people, if asked to do so, are fairly good in estimating annual fatalities of different technologies or natural hazards (see figure 1) (Lichtenstein et al. 1978, Slovic et al. 1985).

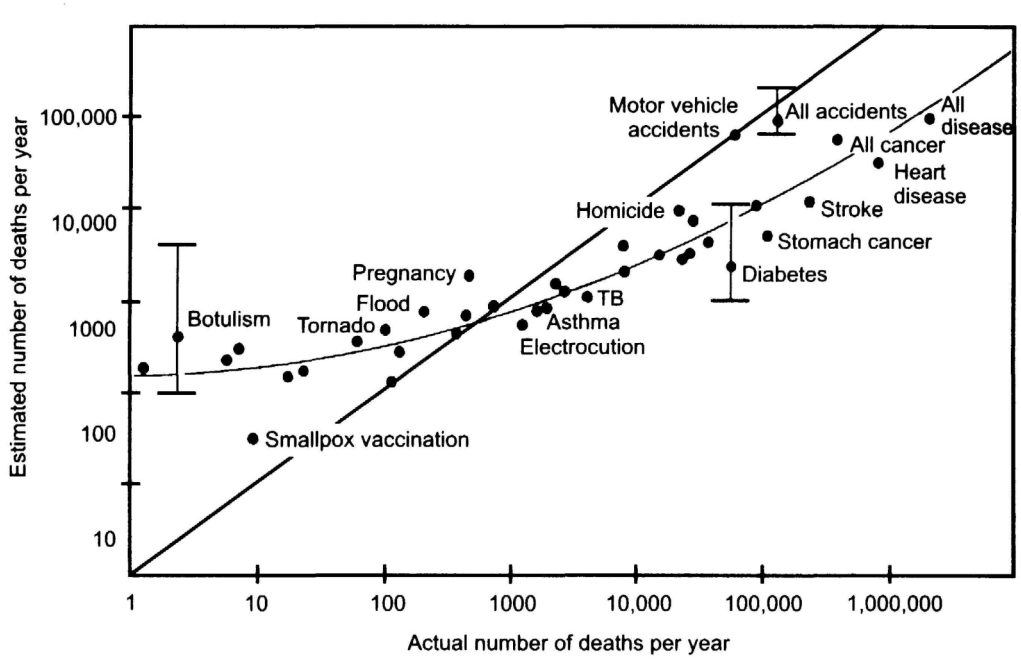

Figure 1: Actual numbers and lay people estimates of deaths per year for a variety of risk topics. Numbers are for the USA. The points and the curve line fitted to them represent the average responses of a large number of lay people. Vertical bars are drawn to depict the 25th and 75th percentile of individual judgement for botulism, diabetes and all accidents. Fifty percent of all judgements fall between these limits. The range of responses for the other risk topics was similar. (source: Slovic et al. 1985)

Lay people, however, use other criteria in evaluating risks. Experts include statistical data such as annual fatalities more frequently in their assessment of risks, but they also seem to be prone to many of the same biases as those of the general public, particularly when experts are forced to go beyond the limits of available data and rely on intuition and

extrapolation (Kahnemann et al. 1982, Henrion & Fischhoff 1986). In addition, psychometric studies include a variety of risks/hazards from different thematic fields such as nuclear energy, smoking, pesticides, tourism, chainsaws, volcanoes, skateboards, asbestos, flooding, home swimming pools or nerve gas accidents. An expert is a specialist in a specific area: that person may be able to grasp a few topics but by no means many or even all of them. Hence, the expert must also rely on intuition and make judgements under a similar bias as lay people do.

Main factors in risk perception

The main qualitative risk perception modulators revealed by the psychometric paradigma are described in this chapter.

Voluntariness

Perception of risk is attenuated if the risk is chosen voluntarily, but amplified if it's imposed (Renn 1992, Jungermann & Slovic 1993a). Even though the risks might be similar, the voluntarily chosen risk is more acceptable than the imposed one. Accordingly, people tend to accept risks that are voluntarily chosen even if those risks are approximately 1000 times as risky as accepted involuntary risks (see figure 2). This involves freedom of choice and the perception of one's own autonomy and responsibility.

First, if the risk is chosen and not imposed, it is a wanted risk – mainly because of some expected benefits related to that risk. The affected person is convinced that he or she would be able to stop the risk at any time. Second, the chosen risk is the best alternative available because it is the best of all possible bad choices. Being able to choose the best alternative also means being able to refuse other and even worse possibilities. Therefore, rejecting less attractive alternatives means a "relative improvement" of the situation. The context in which the chosen risk is situated is dominated by worse risks, and within that frame the selected choice is always better – relatively better – reducing the impression of the absolute risk of the selected choice (Kahneman et al. 1982, see also “frame of reference” in Eagly & Chaikan 1993)

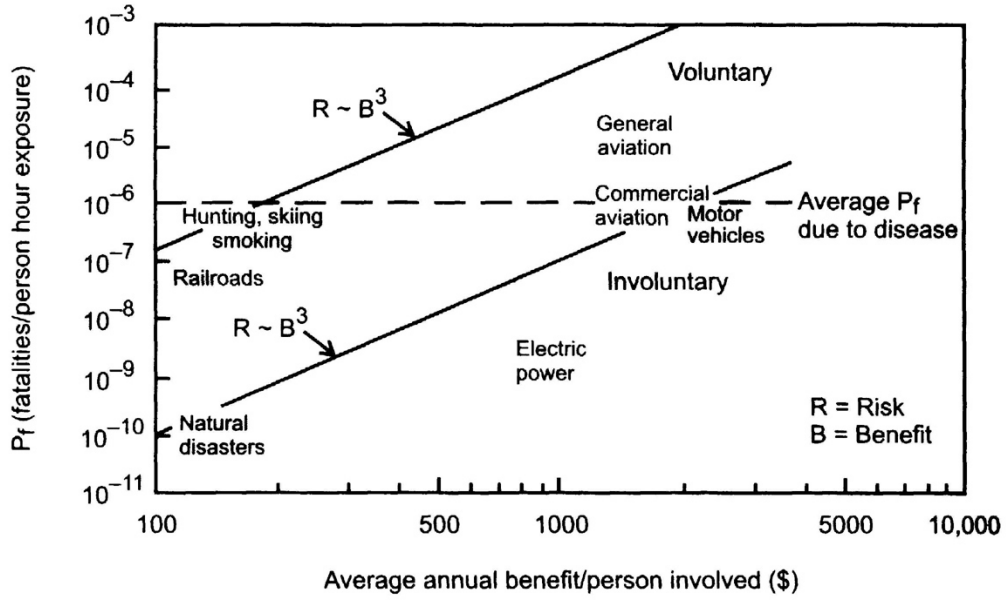

Figure 2: People accept voluntary risks that are approximately 1000 times more risky than involuntary risks. Risk is measured by fatalities per person hour of exposure. Benefits reflect either the average amount of money spent on an activity by any individual participant or the average contribution an activity makes to a participant’s annual income. Lines are drawn with error bands to indicate their approximate nature.

In modern western democracies, the individual right to choose is crucial to society. A set of alternatives translates into less conflict than if only one possibility is imposed because the right to choose has not been restricted. Only if all alternatives are totally unacceptable and truly harmful, then the whole process of choosing is rejected.

Controllability

Similar to the voluntary aspect, risks perceived to be under one`s own control are more acceptable than risks perceived to be controlled by others. Under normal conditions we are unwilling to enter "out of control" situations because we lack security under such circumstances. We have the impression that as long as we maintain control we can – at least partially – remedy that evil. Being unable to gain control of a situation creates a feeling of powerlessness and helplessness: the individual suffers risk!

Note that perceived control isn't necessarily real control. Socio-psychological studies have shown that we tend to overestimate our capability to control a situation. Sjöberg (2000) reports that the personal risk is perceived as being far lower than the risk for people in general, a pattern that was revealed for a wide range of different risk topics. It is interesting that everybody estimates his or her personal risk to be lower than the average risk (see figure 3). This is statistically impossible and reflects an unrealistic optimism. Not all people, for example, can drive more safely than the average citizen. People apparently have great confidence in their own abilities. Pedroso de Lima (1993) even described an effect involving a positive illusion of control, especially in such uncontrollable situations as earthquakes. The consequence is so-called risk denial, expressed by the average risk minus the personal risk; this is clearly correlated with the level of perceived control (see figure 4).

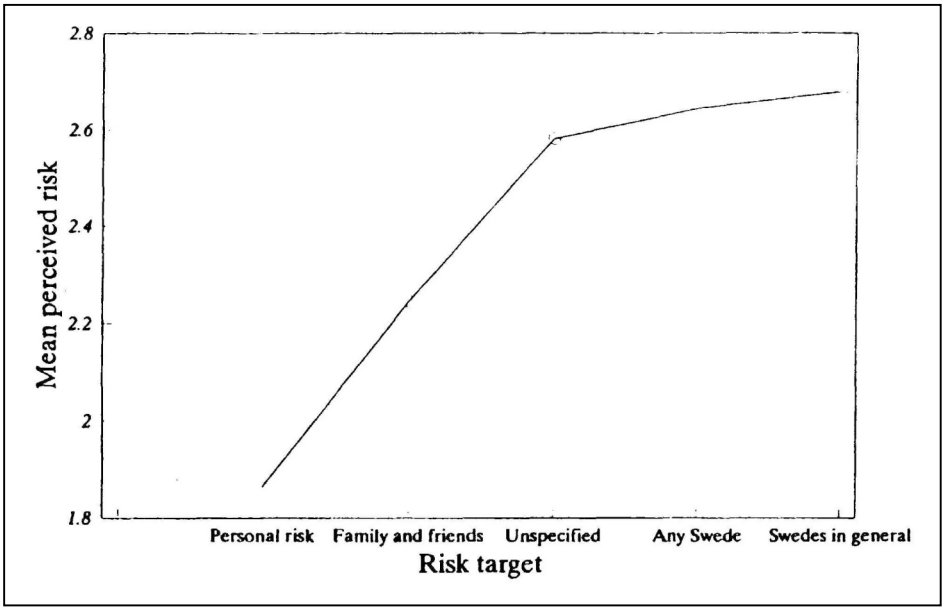

Figure 3: Mean ratings of 27 risks plotted for different target groups (from personal risk to people in general). Each target was rated separately; data are from a study conducted in Sweden (source: Sjöberg 2000).

In certain situations, however, the reverse is also true. For example, if we lack the appropriate skills, we would not want to fly an airplane on our own and would be frightened to death if required to do so. In those situations where we lack the appropriate skills, we have to hand over control. Our perception of security is then mainly influenced by the trust we have in the abilities of the responsible person. Allocating control to a trustful person or institution creates the perception of having regained at least some control of the situation. In earthquake-prone regions, people have expressed higher trust in religious or political institutions (Pedroso de Lima 1993).

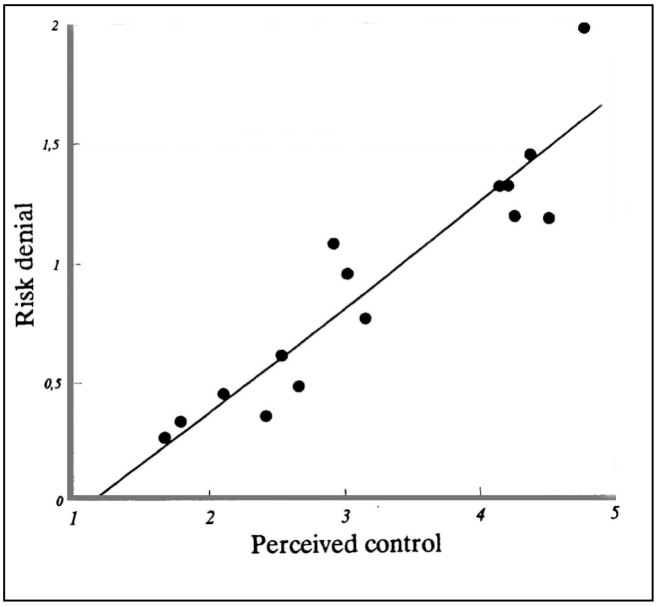

Figure 4: Risk denial (general risk minus personal risk) increases with perceived control. Each point corresponds to one risk (source: Sjöberg 2000).

Delay Effect

The delay effect characterises a lengthy latency between the initial event and the actual impact of damage. The latency could be of physical, chemical or biological nature. The delay effect causes additional difficulties in recognising the effects of a certain risk because the correlation between the initial event and the delayed effect may not be immediately apparent.

Typical examples are smoking and lung cancer, unbalanced fat nutrition and heart disease, the use CFCs and the ozone hole, BSE and Creutzfeld Jakob disease, but also the deployment of genetically modified crops and their potential environmental impact.

Natural vs. Manmade

It makes a great difference in risk perception if the risk or the actual damage is manmade or natural because the latter are more accepted than the former. This involves the control aspect and also incorporates the question of responsibility. We are convinced that a manmade damage could have been avoided by more cautious and prudent behaviour, or by better knowledge about the risky subject. We certify those responsible as being incompetent or careless, and demand that they take responsibility for their incorrect action.

We also might suggest that those responsible failed to appropriately respect the security and health of the affected persons, but instead pursued other goals that were more important (such as saving money by not correctly disposing hazardous sewage, or driving too fast merely for the sake of speed). In the best case the responsible persons were "only" careless, but in the worst case it was done on purpose. In both cases negative intentions are certified.

Conversely, it is obviously senseless to certify a negative intention to natural risks such as earthquakes or tornadoes. These risks are much more accepted because they can't be improved by more prudent behaviour (note that a person's vulnerability can be decreased by taking the right measures against a natural risk). Natural processes are generally better accepted: some believe in God's will, others refer to the laws of nature or simply the world's destiny and fate that must be endured.

Apart from personal beliefs and faith regarding nature, it clearly makes no sense to hold natural processes liable ("You can't sue a lightning bolt!"). We have no influence whatsoever on a meteorite impact, a tsunami or a major earthquake.

In some cases, risks have both a manmade and a natural component and borders between those components increasingly blur. River floods, desertification, and even such complex phenomena as El Niño are thought to reflect global environmental change at least partly caused by humans (WBGU 1998).

Familiarity and Habituation

"Getting used to it" is a major aspect of losing fear! We are much more aware of unknown and new risks. But as we get to know a new risk we gradually habituate and start to accept it. A risk that is present for a long time is attenuated due to habituation, even though the technical risk remains the same (Slovic et al. 1986). This is why known risks are more accepted than unknown risks. Figure 5 clearly shows a double standard in risk tolerance towards voluntary and involuntary activities.

Habituation means that one is getting used to a certain risk, whereas familarity means that the affected person actually knows about the risk. New or exotic risks that have nothing to do with the known world are perceived as more dangerous. Examples include nuclear power and genetic engineering. These examples cause additional problems in the habituation process because we are unable to perceive these risks with our five senses. Lay people can neither control nor observe such exotic risks by themselves (see chapter: controllability). This is why such technologies often elicit resistance and prudent behaviour. Another factor influencing familiarity is time. In contrast to immediate effects, delayed effects tend to hinder familiarity.

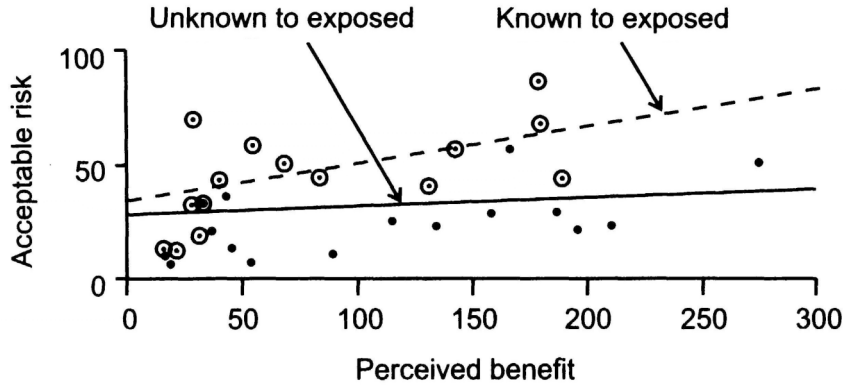

Figure 5: Relationship between perceived benefit and acceptable risk for known (circled) and unknown (dots) risk topics. The 15 most known and the 15 most unknown topics were chosen from a sample of 30 risk topics (source: Fischhoff et al. 2000).

The uncertainty of being exposed or not also influences familiarity. If we know we are exposed to a certain risk, we become familiar with it more quickly (compared to when we are left in the dark about our exposure). Uncertainty plays a major role in risk perception. If a risk is known to science or the affected person, then the contribution to familiarity is higher than if that risk is unknown to science or the affected person (Hazard & Seidel 1993).

The example of the BSE/nv-CJD infection crisis in Europe included many factors that made it difficult to become familiar with that risk: the disease was relatively new, at least to the public. It was not observable (contaminated and normal meat were indistinguishable to the consumer) and the precise transmission of the disease and the danger of infection to humans were unknown to science. This was compounded by the proposed enormous delay effect between actual infection and the outbreak of Creutzfeld Jakob disease. Finally, the public didn't know if they were exposed or not, leading to a massive drop in beef sales. Table 1 summarizes the factors responsible for familiarity.

Table 1: Factors that increase or hinder familiarity with a certain risk.

Increase		Hinder
Observable	↔	Not observable
Known to be exposed	↔	Unknown to be exposed
Immediate effect	↔	Delayed effect
Old risk	↔	New risk
Known to science	↔	Unknown to science

Benefit and Risk-Benefit Distribution

Risks perceived to be fairly distributed are more accepted than risks perceived to be unfairly distributed. The same holds true for the distribution of benefits and, of course, the combination of both. The least acceptable situation is when the risk burden has to be carried by one group of people but the related benefit is gained by a different group (i.e., least acceptable to those carrying the risk). It is also rarely acceptable for the risk to be distributed equally (everyone carries the risk) but only a minority earns the related benefit. Socialising risks and privatising benefits is a recipe for social conflict. Accepting or not accepting a certain form of distribution also depends on different notions of fairness and justice. Three major concepts have been identified to represent a fair distribution or social justice (Davy 1996):

1. Justice is what is beneficial to the strong, or: *maximise liberty*!

2. Justice is what is beneficial to the most, or: *maximise happiness*!

3. Justice is what is beneficial to the poor, or: *minimise pain*!

Whatever notion of justice is favoured, each enables a "fair" or "unfair" distribution.

Risks perceived to have clear benefits are more accepted than risks perceived to have little or no benefit. Individual or group benefits serve as "risk compensation" and, within a certain range, the higher the benefit, the higher the risk we are ready to take. Clearly, people don't take risks merely for the sake of risk itself, but because of the (probable) benefit related to that risk. Accepting risks is easier if clear benefits would otherwise be lost. Choosing between different alternatives always involves choosing between perceived risk-benefit combinations.

Examples of individual benefits and risks include cigarette smoking and driving a car or motorcycle. The taste and feeling of smoking a cigarette apparently override the concerns of related health risks, even if they are known (here, the delay effect also plays a certain role). Driving is one of the most risky activities in modern societies, but the risk is heavily underestimated due to the individual benefit of getting from point A to point B (here, habituation and familiarity also attenuate risk perception).

For community benefits and risk, nuclear power plants can serve as an example. As modern societies are heavily dependent on a secure energy supply to maintain daily life, some countries accept the risk of such a nuclear facility due to the benefit of energy supply (i.e. France). Other countries did not accept the risk due to other alternatives (e.g. Austria, Denmark, Ireland, Portugal).

Another example is the siting of hazardous waste facilities or toxic waste incinerators. As small communities (towns or even villages) have to carry a high risk burden, the "market oriented" solution of dealing with such problems is to offer compensation to locally affected people (see Risk-Benefit distribution). This creates a balanced risk-benefit situation in which a community is more likely to accept a higher risk burden (Linnerooth-Bayer & Fitzgerald 1996).

Of course, both the risks and the benefits are mere perceived risks and perceived benefits. As in the case of perceived risk, the perceived benefit may also be attenuated or amplified by a variety of factors.

The Role of the Media

"Covered or not covered by the media!" That is the question! Of course modern societies are highly influenced by the media – by television, newspapers, magazines, radio and recently the internet. First of all, if the media reports a risk, many people suddenly become aware of it and start to worry. Second, if a risk topic appears in the media (news), then the risk must be real because it has made it into the media! (That logic, while strange, might reflect trust in the competence of the media and in its capability of selecting the "right" topics.)

Risk information can be frightening even when it does not contain a warning. For example a statement by a government official meant to assure that the water is safe to drink, the air is safe to breathe, or the food is safe to eat may have the exact opposite effect. Instead of alleviating concern it may increase fear, anxiety and avoidance of an activity that previously was considered to be safe. The very fact that an official investigation is under way may be sufficient to create an atmosphere of fear and suspicion (Covello et al. 1987).

In terms of numbers, a media-covered risk might be negligible, like the post-September 11 anthrax-threats to US politicians and citizens (in 2 months 4 people became mortal victims), if compared to other risks that are less extensively covered. In the anthrax case, the novelty of the risk, the inability to control it, the unfamiliarity, the suggested terrorist background, a probable hidden agenda and other factors certainly played an important role.

The topics covered in the media probably reflect the individual psychological perception of risk and additionally serve as a risk perception amplifier. On the other hand the interrelation between the media and society is iterative: society is influenced by the media, but the media are also influenced by society (You can only buy what's been selling, and they only sell what's being bought.) (WBGU 1998).

The impact of the media has reached a level of importance that can only be hinted at in this context. Today, the media is one of the main tools to amplify or attenuate a certain (risk) topic.

See table 2 for an overview of the most important psychological and social factors influencing risk perception.

Table 2: Psychological aspects attenuating or amplifying the perception of risk. Note that some aspects are more correlated than others, for example voluntary control and individual control are perceived in a similar way. Of course, trust only plays a role if the risk is at least partially manmade and not natural.

attenuate risk perception		amplify risk perception
familiar	↔	exotic
individual control	↔	controlled by others
natural	↔	manmade
statistical	↔	catastrophic
clear benefits	↔	little or no benefit
fairly distributed	↔	unfairly distributed
voluntary	↔	imposed
information by trusted sources	↔	information by untrusted sources
in the media	↔	not in the media

The Psychometric Paradigm

The psychometric paradigm is used to describe the way lay people judge risks. This is because lay people and experts often define risks differently. As mentioned before experts typically define risk strictly in terms of annual mortalities, while lay people almost always include other factors in their definition of risk, such as catastrophic potential, equity (i.e., whether those receiving benefits from the technology bear their share of risks), effects on future generations, controllability and involuntariness. These differing conceptions often result in lay people assigning relatively little weight to risk assessments conducted by technical experts (Covello et al. 1987, Slovic et al. 1979, Lichtenstein et al. 1978, Slovic et al. 1985b). Experts more frequently include statistical data such as annual fatalities, but they also seem to be prone to many of the same biases as those of the general public, particulary when experts are forced to go beyond the limits of available data and rely on intuition and extrapolation (Kahnemann et al. 1982, Henrion & Fischhoff 1986). In addition, psychometric studies include a variety of risks/hazards from different thematic fields such as nuclear energy, smoking, pesticides, tourism, chainsaws, volcanoes, skateboards, asbestos, flooding, home swimming pools or nerve gas accidents (see figure 2). An expert is a specialist in a specific area. He or she may be able to grasp a few of topics but by no means many or even all of them. Hence, the expert is also forced to rely on intuition and to judge under a bias similar to that affecting lay people.

One of the promising approaches to investigating risk perception is via the psychometric paradigm. It uses psychophysical scaling and factor analysis to produce quantitative representations or “cognitive maps” of risk perception (Fischhoff et al. 1978, Slovic et al 1980). The factor space of the psychometric paradigm has been replicated over the years across groups of lay people and experts (in industrial countries) judging a great number of different risks. It is a well-established model for assessing quantitative judgements about risk (Slovic 1987, Slovic et al. 2000).

The psychometric paradigm is based on the assumption that some characteristics of risks are perceived similarly, e.g. voluntariness is correlated with controllability, catastrophic potential with inequity, observability with knowledge about the risk, and immediacy with novelty. Based on the correlation between some of these risk characteristics –usually called “items” – they can be combined into two or three factors using multivariate factor analysis. Each factor thus consists of several highly correlated items. Former risk perception studies typically identified two to three factors:

1) dread risk
2) unknown risk, and
3) people affected risk

The factor “dread risk” included the following items: perceived lack of control, catastrophic potential, inequitable distribution of risks and benefits and, fatal consequences and dreadful. The “unknown risk” factor consisted of the items observability, experts’ and lay people’s knowledge about the risk, delay effect of potential damage (immediacy) and novelty (new-old). The third factor “people affected risk” summarized the items personally affected, general public affected and future generations affected.

See figure 6 for the location of different risk topics within the risk factor space and the characteristics of the two main factors (Slovic 1987).

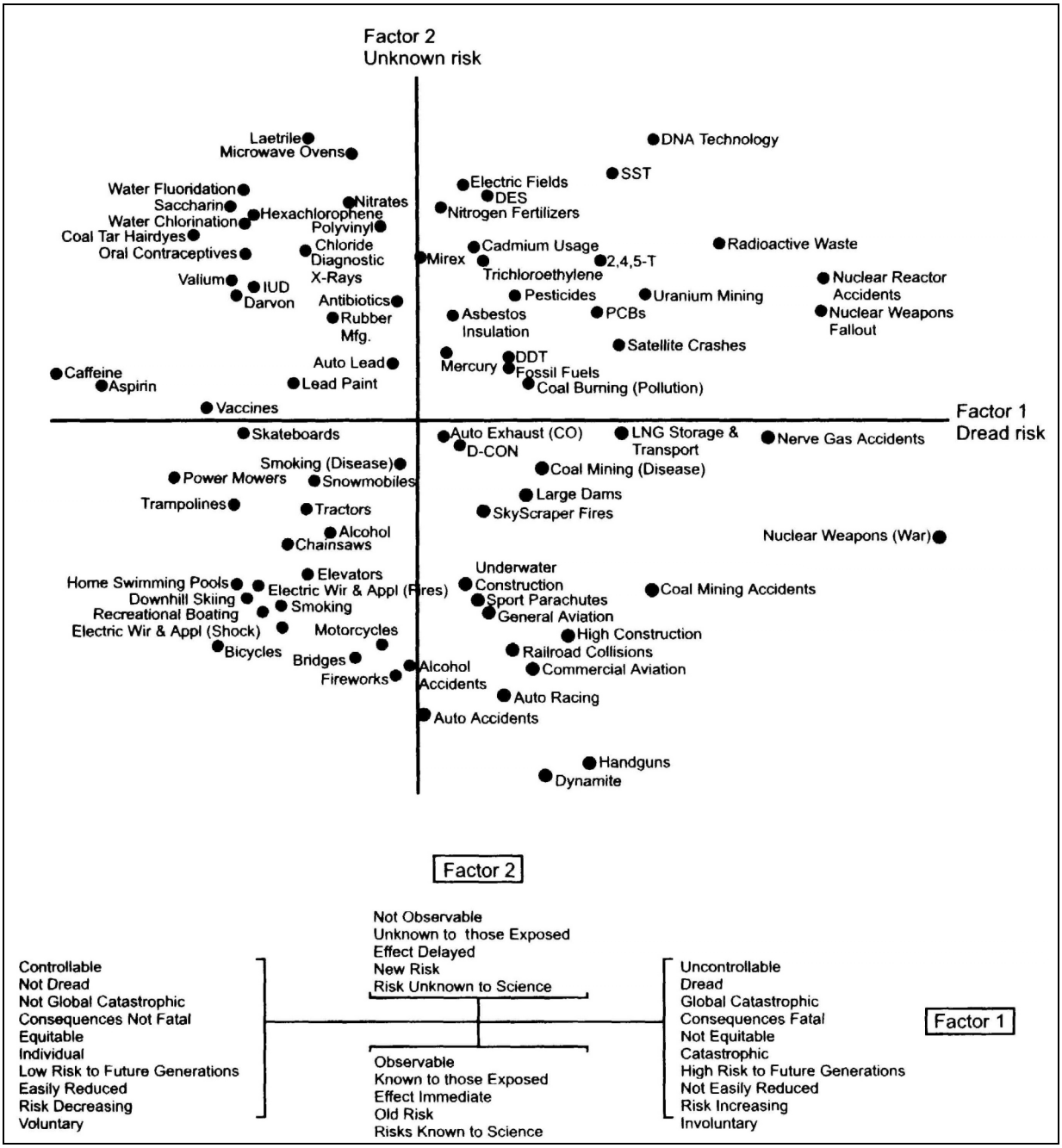

Figure 6: Location of 81 risks on factor 1 (dread) and factor 2 (unknown) derived from the relationships among 18 risk characteristics. See below for the characteristics that compose the factor "catastrophic / dread" and the factor "uncertainty / familiarity" in the factor space (source: Slovic et al. 1987).

Lay people's perception of riskiness is highly correlated to the factor dread. The higher the risk topic is judged on this factor, the higher its perceived risk and the more people want to see its current risks reduced and regulated (Slovic 1987). In those cases in which the risk topic ranks high on the dread risk and unknown risk dimension, e.g. BSE, GMOs, that issue is very likely to be discussed in the general public and in the media. Accidents with these characteristics are seen as "high-signal accidents" causing high societal impact, far higher than the direct immediate costs of the accidents (e.g. Three Mile Island, Chernobyl, Bhopal) (Slovic 1987).

In a study on over- and underestimated risk, Sjöberg showed that risks perceived as dreadful and unknown are frequently overestimated risks. On the other hand, risks that rate low on the dimensions dread and unknown risk are often underestimated by the general public.

"Radiation risks constituted the largest category of risks reported to be over-emphasized. Other risks often reported as over-emphasized include BSE, GMOs, amalgam, and air traffic. Lifestyle risks was the largest category reported to be neglected, and other neglected risks were radon, road traffic, socio-economic risks, energy production (excluding nuclear power), and local accidents." (source: Sjöberg & Fromm 2002)

Studies using the the psychometric paradigm have shown that it is possible to quantify and predict perceived risk. The technique seems appropriate to identify similarities and differences in the perception of different risks. Following this argumentation, the location of a new risk topic in the risk factor space can yield helpful information to forecast public acceptance. If a previously unresearched topic is judged similary as a previously researched topic, then we can expect similar constraints in the discussion of stakeholders.

For example, gene technology and nuclear energy share similar qualitative characteristics within the psychometric factor space. Following public debate on nuclear energy, Slovic (1987) forecasted a similar public debate about GM technology because both GM technology and nuclear energy were judged as unknown, dreadful, uncontrollable, inequitable, catastrophic and likely to affect future generations (see Bauer 1995, Slovic 1987).

(For more information on the underlying theories on risk perception and expert / lay-people differences see for example Covello 1983, Fischhoff 1996, Fischhoff et al. 1981, Lazo et al. 2000, Palma-Oliveira 2001, Renn et al. 1992, Sjöberg 2000, Slovic et al. 1985, Slovic et al. 1986, Slovic 1987, Slovic 2000).

Social and Cultural Aspects

The Cultural Settings

The cultural belief system determines extensively the collective notions of how the world functions (Douglas & Wildavsky 1982, Rayner 1992). These collective notions also contain socially constructed "images" of the world. Social representations comprise the social knowledge of "facts" and "events" shared within a group (i.e. what is dangerous, how to cope with risk or whether the environment is being degraded). Individual aspects of risk perception are influenced by the social community that the individual lives in and vice versa. The cultural setting (or cultural context) is also interrelated to the individual perception as well as to the social system or social community (WBGU 1998).

This social knowledge is essential for the members of this society to evaluate situations and act in an appropriate manner. Understanding the ways in which risks are dealt with requires considering the socio-cultural setting. This means not only the different religious belief systems or the "Eastern" and "Western" culture, but also different subgroups within a culture. Different social representation (subcultures, group-specific knowledge) can thus prevail in various groups within a nation or cultural region (i.e. Western culture).

For example, the people inhabiting tornado-prone regions of Alabama, USA, are largely convinced that what happens to them depends on God or good fortune. In contrast, the inhabitants of Illinois, USA, who are exposed to a similar threat, believe that it is above all their own behaviour that determines their fate. Accordingly, they have implemented protective measures that have considerably reduced the number of deaths caused by storm disasters in Illinois versus Alabama (Sims and Baumann 1972).

Comparisons of risk perceptions between different cultures and nations have also been made in the past, for example between Americans and Japanese, between Germans and Australians (Rohrmann 1995), or between Portuguese and Chinese in Macao (Neto & Mullet 2001). Such studies revealed a difference in the perception of Japanese and Americans in relation to nuclear risks. The Japanese tend to view nuclear risks as being higher, but the voluntariness of exposure to the risk is also viewed as being higher than it is by Americans (Hinman et al. 1993).

The economic situation of persons affected can also influence their way of dealing with risks. For instance, Mexican field workers, whose economic situation leaves extremely little leeway for action, have stated that they do not worry about health impairments caused by pesticides used at work (Vaughan 1993).

Different Notions of Justice and Fairness

As already mentioned in the chapter "Individual aspects", more than only one perception of fairness and justice exist. The three main competing notions are:

1. *Utilitarian or hierarchical justice*: provides least unhappiness or least risk
2. *Libertarian justice or market* solution: minimal state imposition, voluntary market approach by bidding for compensation for high-risk burdens
3. *Rawtesian or egalitarian justice*: allows inequity only if it is beneficial to the least advantaged

In some risk-related decision-making processes the existence of more than one notion of justice causes an "essential injustice" (Davy 1996). Obtaining maximal fairness within one notion of justice neglects the other notions. Thus, the trust may be undermined because it is impossible to always satisfy the different fairness demands. Moreover, the lack of trust (in institutions) leads to an increased perception of risk.

Even though the different notions can be observed in every society, the main focus may differ from country to country. For example, the main notion (that notion that the majority of the people supports) in Austria is hierarchical justice, in the USA libertarian justice (Linnerooth-Bayer & Fitzgerald 1996).

Signal Effect of Local Events

Local effects such as contamination of soil or groundwater with chemical substances, accidents in industrial facilities (i.e. Chernobyl), or disclosure of “genetic pollution” (i.e. in maize landraces in their centre of diversity, Mexico) often have effects that extend beyond the immediate region. Local processes can thus develop a signal effect for society as a whole or even for global risk communication (see Figure 7).

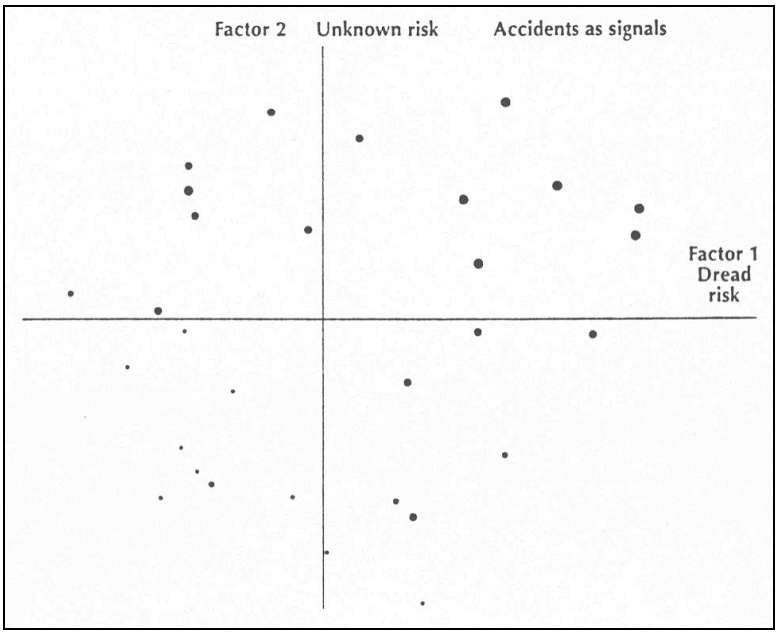

Figure 7: The relation between signal potential and risk characterisation for 30 risks. The larger the point, the greater the degree to which an accident involving that hazard was judged to "serve as a warning signal for society, providing new information about the probability that similar or even more destructive mishaps might occur within this type of activity". Media attention and the higher-order costs of a mishap are likely to be correlated with signal potential (Source: Slovic 1987).

It is therefore insufficient to evaluate risks only from the perspective of their direct effects such as fatalities, persons injured or economic losses. Indirect effects also need to be taken into consideration (Jungermann & Slovic 1993b). These may include:

1. Changed political climate (pressure upon policy makers to avoid certain risks from the outset, social unrest).
2. Changed economic factors (higher costs due to safety requirements, reduced value of real estate, diminished attractiveness for tourism).
3. Emergence of major social movements, often sparked by individual damaging events (i.e. the emergence of the Austrian green movement and green party after social clashes due to a major hydroelectric power station project that would have irreversibly destroyed an important riverine forest and floodplain area").
4. Changed attitudes of broad segments of the population towards certain issues (i.e. scepticism vis-à-vis large-scale technologies), which can influence the perception, evaluation and acceptance of other risks (Renn et al. 1992).

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