How are scientific perceived in

Markus A. Grutsch

It is a fallacy to believe that scientists and experts speak the same language as laypeople when it comes to the potential risks from new technologies. There are many reasons for this. One important point is that experts can normally use objective data to determine risk, such as information on the extent of the damage and the probability of occurrence. On the other hand, non-experts also include other criteria in their assessment of risks, judging risk from a holistic perspective.

It is decisive for personal risk assessment as to whether a risk is assessed as being controllable or whether it is known and familiar. For laypersons, particular perceived characteristics of risks are important such as the perceived "awfulness" tied up with a risk. People's own experience, firm beliefs and outlook on life also play their part in the personal assessment of risk. The media can also make a contribution. Through reporting on current risk events or issues, they are made "intellectually available" to the layman. In the layman's perception of risks, these issues are then cognitively present and, as a rule, risks are assessed as being greater. While such qualitative aspects play a key role for non-specialists, they are not taken into consideration in scientific risk assessment. Figure 1 summarises the central subjective criteria that decisively extend the scientific risk definition.

Role of the depiction of probabilities in the interpretation of scientific knowledge

Apart from the fact that laypersons and experts have a fundamentally different understanding of the term "risk", they also comprehend information on probabilities and risk parameters differently. For instance, particular quantitative representations of risks are, generally speaking, hardly understood or only with difficulty by laypersons. Accounts where the rate of cancer is expressed as 1 : 1,000,000 or 10^{-6} are hardly encountered in everyday life and can thus be difficult to understand. Apart from that, these statistical figures are bound up in a context thus making further misinterpretation possible if appropriate information is not imparted. Gigerenzer (2002) described one well-known example with the statement that tomorrow, there would be a 30% chance of rain. In interpreting this statement, the question arises of what this cited probability refers to. Those questioned understood very different things: Some said that it would rain for 30% *of the time*. Others believed it would rain in 30% *of the region*, and there were also those who said that in the past, it had rained on 30% *of all days* that were like tomorrow.

A further problem in interpreting statistical data is in correctly evaluating the risk with regard to the reference quantity: If it is mentioned that the rate of cancer cases is reduced by 20% by an alternative form of treatment, this seems considerable. However, in order to obtain a thorough interpretation of this statement, it is also necessary to provide the reference figures on which the "success" of this new therapy in

findings on risks the population?

comparison to conventional treatment can be assessed. Thus it does make a difference as to whether the reference figure taken into consideration is 10 or 1000 cases of cancer. As a result, the success would be assessed differently – in the one case with 8, in the other with 800 cases. Verbal descriptions represent another possibility to communicate probabilities. Here too, problems arise, as verbal probability details ("possibly", „seldom" etc.) are often evaluated as being too vague and their interpretation can easily be influenced by the context. For instance, the statement „often going to the cinema" is assigned a different numerical value than "often visiting the USA" (Newstead & Collis, 1987). Verbal descriptions are also used when depicting the state of scientific knowledge of risks. This plays a key role by so-called "unclear" risks in particular – i.e. if the current evidence cannot provide an unequivocal description of the risk. Examples of this are mobile radio communication (mobile telephony) or biotechnology.

Thalmann's study (2005) provided a good example of misinterpretation in verbal descriptions of different scientific risk findings. She was able to show that verbal descriptions of the findings or of the evidence value were understood and/or interpreted by laypersons in a different way to what the experts had meant. Verbal expressions such as "consistent indication" or "suspicion" are ambiguous and context-dependent. Thus lead to major individual differences in their interpretation, and they are used in stark contrast to the way they are (often imprecisely) used in everyday language.

Role of the depiction of uncertainty in the interpretation of scientific knowledge

When interpreting scientific knowledge, the depiction of uncertainty in scientific knowledge represents a contentious point. Many questions still remain open, and only a few empirical studies exist that offer some clarification. The experts are divided into two camps. One group assumes that citing uncertainty about risk potentials makes the general public insecure, triggering indignation and worries among people. Investigations have demonstrated that laypersons also consider such scientific details of uncertainty to be signs of incompetence and dishonesty on the part of scientists (Johnson & Slovic, 1995; Johnson, 2003). Others are of the opinion that citing uncertainty surely increases trust in the communicator (in an authority,

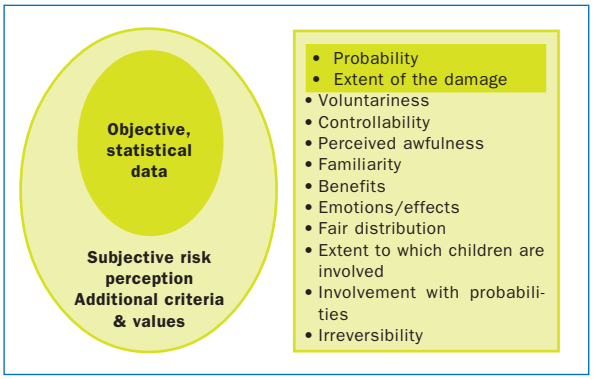

Figure 1: Probability and extent of damage – extended by subjective criteria when risks are assessed by laypersons

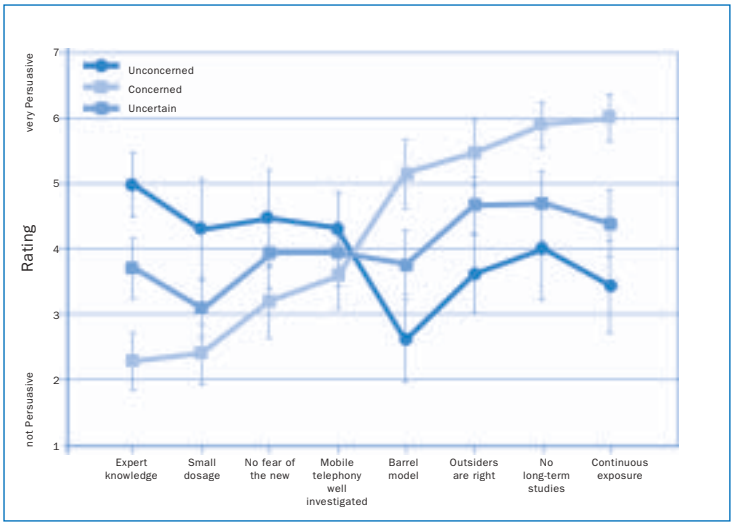

Figure 2: Differences between groups in assessing the power of persuasion of pro-risk and counter-risk arguments (Schütz & Wiedemann, 2004)

for example) (MacGregor, Slovic & Morgan, 1994; McMahan, Witte & Meyer, 1998). The latest findings have shown that the perception of risks or information on risks depends very much on the existing personal convictions and outlooks towards the subject concerned (e.g. mobile telephony, genetic engineering, etc). In addition, information on the risk communicator (whether a representative of the authorities, industry or a non-governmental organisation is acting as the communicator) also influences the interpretation of the uncertainty or risk (Kuhn, 2000).

Role of the personal convictions in the interpretation of scientific knowledge

As already mentioned in the introduction, personal convictions also play an important role in the perception of risks. In connection with the interpretation of scientific insights, it is an interesting fact that convictions acquire a "filter function", which influences the ability to receive information, for instance. This is shown by our studies on the assessment of the persuasiveness of risk arguments (Schütz & Wiedemann, 2004; Grutsch & Thalmann, 2004). People were presented with pro-risk and counter-risk arguments in order to investigate their power to persuade. The findings presented a clear picture: People who are concerned about the risks of mobile telephony or convinced that it is dangerous, consider those arguments more effective that indicate the harmfulness of mobile telephony. People, however, who are untouched by the discussion of the risks of mobile radio communication and who do not think about the possible harm that might arise from it, prefer arguments that classify the risks as low or rule the risks out altogether. There is one further group of people - those who still do not have an opinion about the possible risks: those who are still uncertain. These people's evaluations are somewhere between the other groups of people. Figure 2 shows the assessments broken down by "attitude groups"; the first four arguments shown are "counter" ones. The remainder are pro-risk arguments (see appendix[1] for wording).

The role of the „information frame" in the interpretation of scientific knowledge

An item of information on risks is rarely displayed in a purely "factual" way. Think about the media, whose daily bread is earned by providing us with stories. The communication of risks is also affected by this. It is not unusual for information on risks to be packed up in stories, that show an "objective" risk in a different light depending on how the facts are stage-managed. Thus it makes a difference whether the company responsible for an accident with chemicals is characterised as a "ruthless conglomerate following minimum safety stipulations" or as "a small, local business whose safety standards are stricter than is usual" (Wiedemann, Clauberg & Schütz, 2003). The debate about the risks of mobile radio communications is similar, in which the lines between supporters and opponents are deadlocked: Information on potential risks is frequently displayed within a very partial "frame". Thus proponents talk of "safety management" in the context of the potential dangers of mobile radiotelephony, while radical critics talk of „active defence" (Thalmann, Grutsch, Bernhard & Wiedemann, 2004). In short: The same picture – but surrounded by two different "frames".

Summary

In conclusion, it must be noted that a number of different criteria play a role when interpreting scientific knowledge of risks. On the one hand, risks are assessed in different ways, as laypersons and experts relate to different evaluation criteria. On the other hand, the central characteristics of risks are frequently interpreted incorrectly for reasons of heuristics, i.e. simplified rules on interpretation and drawing conclusions. Alongside these cognitive assessment errors, other factors, such as personal convictions, for example, also play a critical role in the interpretation of scientific knowledge. Convictions operate like filters, letting particular compliant items of information seep through so that only specific information aspects are "allowed" when making an assessment. Filtering of this kind can also be promoted by particular ways of displaying information. One example for this is the context in which an item of information is embedded. This means that the knowledge of distortions and misinterpretations has to be taken into account when disseminating scientific knowledge, in order to make fair communication possible. When developing risk information, knowledge from risk communication research must also be included to allow the evidence-based depiction of scientific expertise, which can then be effectively communicated.

Markus A. Grutsch, Programmgruppe Mensch, Umwelt, Technik (MUT), Forschungszentrum Jülich GmbH

Literature

- Gigerenzer, G. (2002). *Reckoning with risk. Learning to live with uncertainty*. London: Penguin.
- Grutsch, M.A. & Thalmann, A.T. (2004). Vor was zittern die Polen? Eine Risikowahrnehmungsstudie in Polen unter besonderer Berücksichtigung des Mobilfunks. *Arbeiten zur Risiko-Kommunikation, 87*. Forschungszentrum Jülich: MUT.
- Johnson, B.B. (2003). Further notes on public response to uncertainty in risks and science. *Risk Analysis, 23* (4): 781-789.
- Johnson, B.B. & Slovic, P. (1995). Presenting uncertainty in health risk assessment: Initial studies of its effects on risk perception and trust. *Risk Analysis, 15* (4): 485-494.
- Kuhn, K.M. (2000). Message format and audience values: Interactive effects of uncertainty information and environmental attitudes on perceived risk. *Journal of Environmental Psychology, 20*: 41-51.
- Newstead, S.E. & Collis, J.M. (1987). Context and the interpretation of quantifiers of frequency. *Ergonomics, 30*: 1447-1462.
- MacGregor, D.G., Slovic, P. & Morgan, M.G. (1994). Perception of risk from electromagnetic fields: A psychometric evaluation of a risk-communication approach. *Risk Analysis, 14 (5)*, 815-828.
- McMahan, S., Witte, K. & Meyer, J. (1998). The perception of risk messages regarding electromagnetic fields: Extending the extended parallel process model to an unknown risk. *Health Communication, 10 (3)*, 247-259.
- Schütz, H. & Wiedemann, P.M. (2004). Mobile Ängste: Gruppenspezifische Rezeption von Risikoargumenten beim Mobilfunk. *Strahlenschutz-Praxis, 10* (4), 8-14.
- Thalmann, A.T. (2005). *Risiko Elektrosmog – Wie ist das Wissen in der Grauzone zu kommunizieren?* Weinheim: Beltz PVU.
- Thalmann, A.T., Grutsch, M.A., Bernhard, M. & Wiedemann, P.M. (2004). Pilotstudie zur Entwicklung eines Bewertungsansatzes für Mobilfunk-Informationen. *Arbeiten zur Risiko-Kommunikation, 88*. Forschungszentrum Jülich: Programmgruppe Mensch, Umwelt, Technik.
- Wiedemann, P.M., Clauberg, M. & Schütz, H. (2003) Understanding amplification of complex risk issues: the risk story model applied to the EMF-case. In N. Pidgeon, R.E. Kasperson & P. Slovic (Hrsg.), *The Social Amplification of Risk* (pp. 286-305). Cambridge University Press

Footnotes

[1] The warning arguments:

Mobile radio communication (mobile or cellular telephony) is a new technology. So far there have not been any long-term investigations conducted over ten years or more. Thus a great deal of caution is called for in connection with mobile telephony (in short: *no long-term studies*).

If people are continuously subjected to radiation this can lead to health risks over time. Mobile phone base stations are in 24/7 operation. This is why mobile telephony is a risk (*continuous exposure*).

If we think about the way environmental pollution affects people, we can imagine the human body as a barrel, slowly filling up with pollutants. At some time, even a small amount more, for instance the electro-smog caused by mobile telephony can cause the barrel to overflow. And that is why mobile telephony is a risk (*barrel model*).

Again and again, there have been cases where scientific outsiders – opposed to dominant scientific thinking – were proven right with their evaluations of risks. This may also be the case with mobile telephony. For that reason it cannot be ruled out that mobile telephony is a risk (*outsiders*).

The arguments that give it the „all-clear":

People have always been afraid of new technologies. After the invention of the telephone, for instance, it was believed that making telephone calls was hazardous to health. This was later shown to be incorrect. So the mere fact that something is new is no reason for fear. The same also goes for mobile telephony (*fear of the new*).

Only experts of international renown, working together on recognized bodies possess the required specialist knowledge to be able to assess the risks of mobile telephony. These committees conclude that there is no justified suspicion of risk. For this reason, mobile telephony is harmless to your health (*expert knowledge*).

There have been approx. 30,000 scientific works on the biological effects of electromagnetic fields. This is more than on other new technologies. So it can be said that mobile telephony has been well investigated (*well investigated*).

In assessing the risks, the dosage – in other words the amount or intensity of the pollutant that the human being is subjected to – is decisive. This dosage can be so low that no risk any longer exists. People living near mobile phone base stations are only subjected to very low electromagnetic fields. This is why the base stations do not represent any source of risk (in short: *small dosage*).