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Not 100% sure? The 'public' understanding of risk

All knowledge is provisional, subject to revision in the light of new information. Knowledge is probabilistic. Some beliefs might be assigned infinitesimal probabilities – creationism and intelligent design perhaps – but all probabilities must be treated as revisable in the light of new evidence. Where knowledge (belief) relates to potential future harms or benefits, as it usually does in situations where science communication is seen as problematic or contentious, the issue can be framed as one of risk communication.

WHAT IS RISK?

There are many ways in which one can categorize problems of risk and its management. Typing the single word 'risk' into Google produces hundreds of millions of hits. One need sample only a small fraction in order to discover unnecessary and often acrimonious arguments caused by people using the same word to refer to different things and shouting past each other. Figure 6.1 proffers a typology that has proved helpful in clearing away some unnecessary arguments.

Some risks are visible to the naked eye. We manage them using *judgment*. We do not undertake a formal probabilistic risk assessment before crossing the road; some combination of instinct, intuition and experience usually sees us safely to the other side.

Others are perceptible only to those armed with microscopes, telescopes, surveys, scanners and other measuring devices, and the data they produce. This is the realm of quantified risk assessment. In this realm uncertainty comes with numbers attached in the form of probabilities.

Successful Science Communication, ed. D. J. Bennett and R. C. Jennings. Published by Cambridge University Press.

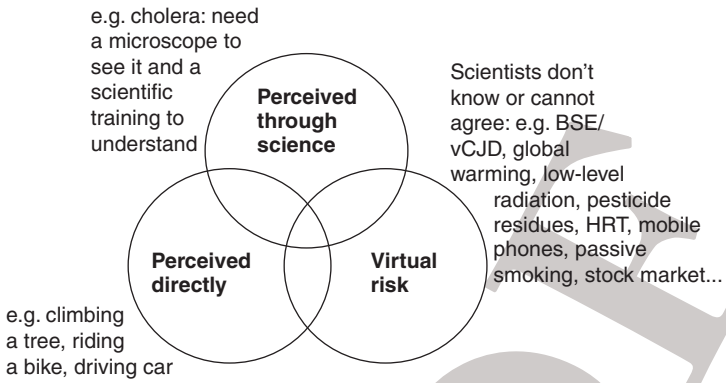

Figure 6.1 Different kinds of risk.

In this circle one also finds attempts to attach magnitudes to the consequences of a risk materializing – often expressed in monetary terms. So commonly we find the expression Risk = Probability × Magnitude.

Virtual risks may or may not be real – scientists disagree – but beliefs about them have real consequences. The uncertainty is liberating; if science cannot settle the issue people feel free to argue from their beliefs, convictions, prejudices or superstitions. Here we are thrown back, as in the first circle, on judgments that cannot be objectively validated.

THE RISK THERMOSTAT

Figure 6.2 proffers the essence of the process of risk management. It describes the Risk Thermostat. 'Propensity' in this diagram represents the setting of the thermostat. Some are set high, others low. I have yet to meet anyone with a thermostat set to zero; life would be unutterably boring.

Propensity leads to risk-taking behaviour that leads, by definition, to accidents: to take a risk is to do something that carries with it a probability of an adverse outcome. Through surviving accidents and learning from them, or seeing them on television, or being warned by mother, we acquire our perception of safety and danger. The model postulates that when propensity and perception get out of balance we behave in a way that seeks to restore the balance. Why do we take risks? There are rewards, and the model proposes that the magnitude of the reward influences propensity.

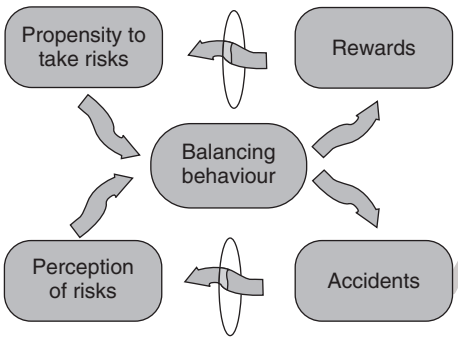

Figure 6.2 The Risk Thermostat with perceptual filters.

For most economists and psychologists today the idea of 'risk compensation', as this process is commonly known, is axiomatic; while in pursuit of opportunities, we scan our environment for evidence of safety and danger and modify our behaviour in response to what we observe. The insurance industry knows the phenomenon as 'moral hazard'; if you have house contents insurance you are less careful about locking up, or if you are the president of a bank that is to big to fail you will sell more sub-prime mortgages. Where the phenomenon is still the subject of debate, the argument now is usually not about its existence but about the magnitude of its effect – is the behavioural response to perceived changes in risk, partial, complete, or more than complete?

Most institutional risk management, outside the offices of venture capitalists, hedge funds managers and sub-prime mortgage brokers, is devoted to the prevention of bad things happening. It is focused on the bottom loop of Figure 6.2. It is risk averse.

This bottom loop bias colours the reporting of most scientific risk stories – '*if it bleeds it leads*' in journalistic parlance. But not always and everywhere. Reporting of the 'sub-prime credit crunch' frequently identified top-loop bias – incentive structures that offer enormous rewards for taking risk-free risks with other people's money – as an important inflator of the financial bubble that burst with such devastating effect.

PERCEPTUAL FILTERS

It is commonly alleged by people struggling to put across scientific messages that 'the public' craves certainty and cannot cope with the provisional nature of scientific knowledge. This seems unlikely. The public after all buys millions of pounds worth of lottery tickets

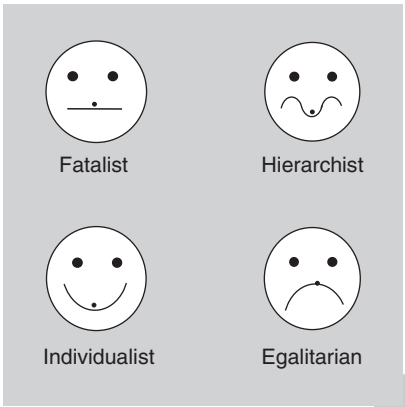

Figure 6.3 A typology of perceptual filters.

every week[1] and a significant number regularly visit bookmakers. A more likely explanation of the difficulties encountered by those charged with communicating scientific information to the public is that there is no such beast as 'the public'. There are many publics and they perceive and respond to uncertainty differently.

The Risk Thermostat of Figure 6.2 comes equipped with perceptual filters. Cultures and individuals vary widely in their perception of risks. Figure 6.3 proffers a cartoon version of a typology of commonly encountered responses to risk developed in a branch of anthropology called cultural theory. These are caricatures, but nevertheless recognizable types that one encounters in debates about threats to safety and the environment. With a little imagination you can begin to see them as personalities. In a report for Britain's Health and Safety Executive (HSE) (Adams and Thompson, 2002) they are described as follows:

- Individualists are enterprising 'self-made' people, relatively free from control by others, and who strive to exert control over their environment and the people in it. Their success is often measured by their wealth and the number of followers they command. They are enthusiasts for equality of opportunity and, should they feel the need for moral justification of their activities, they appeal to Adam Smith's Invisible Hand which ensures that self-interested behaviour in

[1] It is sometimes argued that this behaviour in the face of such daunting odds demonstrates a failure to understand quantified uncertainty, but where else can one buy so much fantasy for £1?

a free market operates to the benefit of all. The self-made Victorian mill owner or present-day venture capitalist would make good representatives of this category. They oppose regulation and favour free markets. Nature, according to this perspective, is to be commanded for human benefit. They are prone to top-loop bias.

- Egalitarians have strong group loyalties but little respect for externally imposed rules, other than those imposed by nature. Human nature is – or should be – cooperative, caring and sharing. Trust and fairness are guiding precepts and equality of outcome is an important objective. Group decisions are arrived at by direct participation of all members, and leaders rule by the force of their arguments. The solution to the world's environmental problems is to be found in voluntary simplicity. Members of religious sects, communards and environmental pressure groups all belong to this category. Nature is to be obeyed and respected and interfered with as little as possible. They are advocates of the precautionary principle and prone to bottom-loop bias.
- Hierarchists inhabit a world with strong group boundaries and binding prescriptions. Social relationships in this world are hierarchical with everyone knowing his or her place. Members of caste-bound Hindu society, soldiers of all ranks and civil servants are exemplars of this category. The hierarchy certifies and employs the scientists whose intellectual authority is used to justify its actions. Nature is to be managed. They are devotees of cost–benefit analysis and nervous in the presence of uncertainties that preclude the possibility of attaching uncontested numbers to the variables they are supposed to be managing.
- Fatalists have minimal control over their own lives. They belong to no groups responsible for the decisions that rule their lives. They are non-unionised employees, outcasts, refugees, untouchables. They are resigned to their fate and see no point in attempting to change it. Nature is to be endured and, when it's your lucky day, enjoyed. Their risk management strategy is to buy lottery tickets and duck if they see something about to hit them.

In our report we explained to the HSE that in the terms of this typology they were statuary Hierarchists; they who make the rules and enforce

the rules. For the foreseeable future we predicted they could expect to be attacked from the Egalitarian quadrant for not doing enough to protect society, and from the Individualist quadrant for over-regulating and suffocating enterprise.

Figure 6.3 represents a first-order categorization; within each quadrant many further sub-categories can be found. Occupants of all four quadrants are all familiar with the concept of uncertainty but respond to it very differently. Consider this exchange, reported in Hansard, during the House of Lords inquiry into the safety of genetically modified organisms:

> Lord Reay (Chairman) *Your opposition to the release of GMOs, that is an absolute and definite opposition? It is not one that is dependent on further scientific research or improved procedures being developed or any satisfaction you might get with regard to the safety or otherwise in future?*
>
> (Lord Melchett) *It is a permanent and definite and complete opposition based on a view that there will always be major uncertainties. It is the nature of the technology, indeed it is the nature of science, that there will not be any absolute proof. No scientist would sit before your Lordships and claim that if they were a scientist at all*. (House of Lords Select Committee on GM Crops, Minutes of Evidence, 3 June 1998)

Here the difficulty for advocates of genetic modification is not Lord Melchett's failure to understand uncertainty; indeed he prays it in aid. It lies in his assessment of the potential costs and benefits of the technology. As noted above risk approached scientifically is often presented as an equation: Risk = Probability × Magnitude. With novel technologies there is limited evidence upon which to base estimates of probability, and even less upon which to base estimates of magnitude – positive or negative. So long as genetic modification remains in the virtual risk category of Figure 6.1 participants in debates about it will remain free to imagine the worst.

Or the best. Matt Ridley (2010) argues that its safety has been proven – *'More than a trillion GM meals have been eaten worldwide and nobody is known to have had a tummy upset as a result'* – and focuses on the potential rewards of the technology: higher yields, more efficient use of water, less fertilizer, herbicides and pesticides, and *'spectacularly good for wildlife'*.

Ridley is one of Britain's best-known science communicators. The varied response to his most recent book *The Rational Optimist* highlights the challenge of virtual risks. His book was the focus of a two-page interview in *New Scientist*[2] – Britain's leading popular

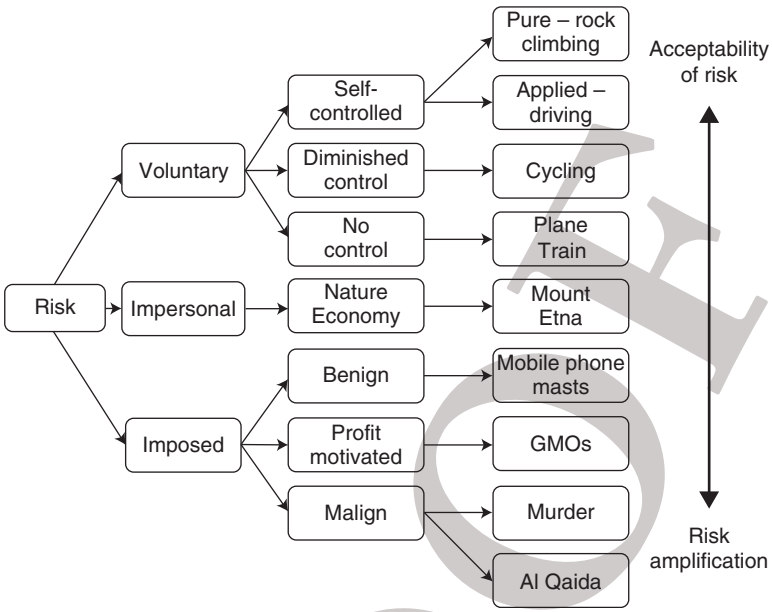

Figure 6.4 Risk acceptability and risk amplification: what kills you matters.

science journal. The interview compares him to Voltaire's Doctor Pangloss. It does not challenge his contention that for billions of people life has improved over the past 50 years – *'we've seen extraordinary improvements in human health, income and lifespan'* – but concludes pessimistically that *'past performance is no guide to the future.'* Sadly in the face of scientific uncertainty we don't have many better guides.

WHAT KILLS YOU MATTERS

Figure 6.4 illustrates another way of classifying risks that can also help clear out of the way some unnecessary arguments.

Acceptance of a given actuarial level of risk varies widely with the perceived level of control an individual can exercise over it and, in the case of imposed risks, with the perceived motives of the imposer.

With 'pure' voluntary risks, the risk itself, with its associated challenge and rush of adrenaline, is the reward. Most climbers on

[2] When optimism know no bounds, *New Scientist*, 12 June 2010.

Mount Everest and K2 know that it is dangerous and willingly take the risk (the fatality rate on K2 – fatalities/those reaching the summit – is reported to be 1 in 4).

With a voluntary, self-controlled, applied risk, such as driving, the reward is getting expeditiously from A to B. But the sense of control that drivers have over their fates appears to encourage a high level of tolerance of the risks involved.

Cycling from A to B (I write as a London cyclist) is done with a diminished sense of control over one's fate. This sense is supported by statistics that show that per kilometre travelled a cyclist is much more likely to die than someone in a car. This is a good example of the importance of distinguishing between relative and absolute risk. Although much greater, the absolute risk of cycling is still small – 1 fatality in 25 million kilometres cycled; not even Lance Armstrong can begin to cover that distance in a lifetime of cycling. And numerous studies have demonstrated that the extra relative risk is more than offset by the health benefits of regular cycling; regular cyclists live longer.

While people may voluntarily board planes, buses and trains, the popular reaction to crashes in which passengers are passive victims suggests that the public demand a higher standard of safety in circumstances in which people voluntarily hand over control of their safety to pilots, or bus or train drivers.

Risks imposed by nature – such as those endured by people living on the San Andreas Fault or the slopes of Mount Etna – or by impersonal economic forces – such as the vicissitudes of the global economy – are placed in the middle of the scale. Reactions vary widely. Such risks are usually seen as motiveless and are responded to fatalistically – unless or until the risk can be connected to base human motives. The damage caused by Hurricane Katrina to New Orleans is now attributed more to willful bureaucratic neglect than to nature. And the search for the causes of the economic devastation attributed to the 'credit crunch' has become focused on the enormous bonuses paid to the bankers who profited from the subprime debacle.

Imposed risks are less tolerated. Consider mobile phones. The risk associated with the handsets is either non-existent or very small. The risk associated with the base stations, measured by radiation dose, unless one is up the mast with an ear to the transmitter, is orders of magnitude less. Yet all around the world billions of people are queuing up to take the voluntary handset risk, and almost all the opposition is focused on the base stations, which are seen by objectors as impositions. Because the radiation dose received from the handset

increases with distance from the base station, to the extent that campaigns against the base stations are successful, they will increase the distance from the base station to the average handset, and thus the radiation dose. The base station risk, if it exists, might be labelled a benignly imposed risk; no one supposes that the phone company wishes to murder all those in the neighbourhood.

Even less tolerated are risks whose imposers are perceived to be motivated by profit or greed. In Europe, big biotech companies such as Monsanto are routinely denounced by environmentalist opponents for being more concerned with profit than the welfare of the environment or the consumers of its products.

Less tolerated still are malignly imposed risks – crimes ranging from mugging to rape and murder. In most countries in the world the number of deaths on the road far exceeds the numbers of murders, but far more people are sent to jail for murder than for causing death by dangerous driving. In the United States in 2002 16000 people were murdered – a statistic that evoked far more popular concern than the 42000 killed on the road – but far less concern than that inspired by the zero killed by terrorists.

Which brings us to terrorism and Al Qaida. How do we account for the massive scale, worldwide, of the outpourings of grief and anger attaching to its victims, whose numbers are dwarfed by victims of other causes of violent death? In London 52 people were killed by terrorist bombs on 7 July 2005, about six days' worth of death on the road. But thousands of people do not gather in Trafalgar Square every Sunday to mark, with a three-minute silence, their grief for the previous week's road accident victims. The malign intent of the terrorist is amplified by governments who see it as a threat to their ability to govern. To justify forms of surveillance and restrictions on liberty previously associated with tyrannies 'democratic' governments now characterize terrorism as a threat to Our Way of Life.

WHO'S TO BLAME?

The drunk notoriously searches for his keys not in the dark where he dropped them, but under the lamp-post where he can see (Figure 6.5). This is an apt metaphor for much of what is written on the subject of risk management.

Lord Kelvin famously said, '*Anything that exists, exists in some quantity and can therefore be measured*.' This dictum sits challengingly alongside that of another famous scientist, Peter Medawar (1967) who observed,

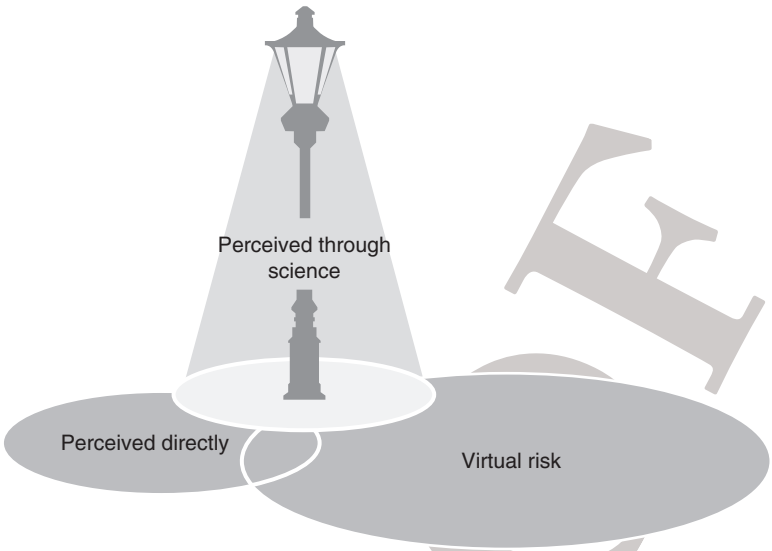

Figure 6.5 Risk: where are the keys?

> *If politics is the art of the possible, research is the art of the soluble. Both are immensely practical minded affairs. Good scientists study the most important problems they think they can solve. It is, after all, their professional business to solve problems, not merely to grapple with them.* [emphasis added]

Risk is a word that refers to the future. It has no objective existence. The future exists only in the imagination. There are some risks for which science can provide useful guidance to the imagination. The risk that the Sun will not rise tomorrow can be assigned a very low probability by science. And actuarial science can estimate with a high degree of confidence that the number of people killed in road accidents in Britain next year will be 2500, plus or minus a hundred or so.

But these are predictions, not facts. Such predictions rest on assumptions; that tomorrow will be like yesterday; that next year will be like last year; that future events can be foretold by reading the runes of the past. Sadly, the history of prediction contains many failures – from those of stock market tipsters to those of volcanologists seeking to predict eruptions, earthquakes and tsunamis. In the area lit by the lamp of science one finds risk management problems that are potentially soluble by science. Such problems are capable of clear definition relating cause to effect and characterized by identifiable statistical regularities.

On the margins of this circle one finds problems framed as hypotheses, and methods of reasoning, such as Bayesian statistics, which

guide the collection and analysis of further evidence. As the light grows dimmer the ratio of speculation to evidence increases. In the outer darkness lurk unknown unknowns. Here lie problems with which, to use Medawar's word, we are destined to 'grapple'.

The problem for science communicators is that we, scientist and non-scientist alike, do not respond blankly to uncertainty. We impose meaning upon it. The greater the uncertainty the greater becomes the influence of the perceptual filters in Figure 6.2. The different perspectives summarized in Figure 6.3 have deep cosmological roots and are not easily shifted. Perhaps the best that a science communicator can hope for is that introspection might assist recognition of one's own biases, and an awareness of the inevitability of different biases in others. Self-knowledge and an ability to stand metaphorically in the shoes of others are key ingredients of the empathy essential to effective communication.

Key resources

My website – www.john-adams.co.uk

My latest book – *Risk*, first published, 1995, UCL Press; third impression 1996, fourth impression 1998, fifth impression 2000; first published, 2001, Routledge: Taylor & Francis e-Library 2002 – ISBN-13: 978–1857280685

Simon Jenkins (http://www.guardian.co.uk/profile/simonjenkins) and Ben Goldacre (http://www.badscience.net/) are journalists who routinely do a good job of dealing with risk.

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