

Risk and uncertainty

At the frontiers of science, we don't always know what may happen.

Robert May

The science we encounter at school deals mainly with crisp certainties, such as newtonian predictions of planetary orbits or the underlying reasons for arranging elements in the periodic table. Otherwise, science appears as rather tedious lists of names — of chemicals or plants and animals — in the trivial guise of a television quiz. This situation is as understandable as it is unfortunate: understandable because such certainties, derived from yesterday's research, are naturally easier to teach; and unfortunate because the implied equation of science with certainty is misleading.

The 'already understood' is thus the limit of most people's acquaintance with science. Insofar as uncertainty enters, it is because the underlying laws, although known, manifest themselves in a sufficiently complicated way that only probabilistic statements can be made. Examples range from roulette wheels to the chaotic dynamics of local weather prediction. Given this conception, or misconception, of what science is all about, it is not surprising that people expect scientists to give them clear and unambiguous advice when new and worrying problems appear.

Difficulties arise when the uncertainties in scientific advice to policy-makers are not caused by probabilistic predictions, but rather derive from a fundamental lack of understanding of new phenomena at or beyond the frontiers of present knowledge. Having met science as 'the known', many people balk at scientists saying "I do not know, but here is a reasonable guess". Zealots who preach a particular answer with unfounded but unshakable belief often make these problems worse.

Medical advances have not only lengthened life expectancy, but have also reduced its variance in the developed world; we now regard three score years and ten as a basic right, and look for someone to sue if a relative does not get them. Such expectation of longer and healthier lives results, I think, in our often worrying about relatively minor

risks in ways that an earlier age would find incomprehensible. Today, some parents are just as concerned about conjectured risks from vaccinations as an earlier generation of parents was about the very real risks of childhood infections such as poliomyelitis. By the same token, many people happily accept risks where they have the illusion of control (driving cars, for example) whereas they flatly reject risks of vastly lower probability, which, however, have a 'miasmatic' quality, such as the perceived risks from radiation. Such subjective perceptions create their own realities, but they frequently ignore objective or 'scientific' approaches to risk analysis.

Whether scientific advice is a confident prediction, a statistical distribution of outcomes, imaginative guidance when we are scientifically ignorant, or nothing more than a sharper set of questions to guide us in the fog, the results will necessarily play out in an arena shaped by public perceptions. Public attitudes to risks can be hugely affected by the emotional colour of particular words. In Britain, the public-health benefits of irradiated food have not been realized as they have in many other countries, essentially as a result of public reaction to the word 'irradiated', with its misleading echoes of nuclear radiation. Appreciating this point, the medical community delivered the benefits of 'nuclear magnetic resonance' techniques, without evoking anxiety, by renaming it 'magnetic resonance imaging'.

Conversely, there are strong indications that heavy intake of vitamin B₆ can be harmful, but proposed restrictions caused an outcry from people who felt that a vitamin must, by definition, be beneficial. As another example, I share many of the environmental ideals of the organic farming movement, but I find it fascinating how the word 'organic' has been cut free from any biological moorings and made emotive, synonymous with 'good' — whereas many 'organic' plants contain naturally occurring toxins.

There are substantial questions that need answering in relation to genetically modified foods, especially in their potential for further intensification of agriculture with consequences for the countryside and the plants and animals in it. But much of the discussion has been conducted in terms of the emotional loading on words such as 'mutant' or 'genetic' — not to mention "Frankenstein foods" — in ways that create feelings divorced from factual underpinning. Today in Europe, many people feel apprehensive about mixing genetically engineered soya beans with those produced as a result of generations of artificial selection,



Uncertain outcome: even with sophisticated data collection and computation, weather prediction is still probabilistic.

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whereas such mixing causes little concern in the United States. It is easy to forget that, when the underlying gene-splicing technology was first emerging in the 1970s, it was Americans but not Europeans who were apprehensive. At one major debate of that time in Cambridge, Massachusetts, one speaker began by intoning "nicotine, cigarettes" and then "gene splicing, genetic engineering", observing that although the former words have little emotional resonance, the latter cause shivers. But the first set of words stand for demonstrable harm on a large scale, whereas the latter do not.

The past century saw great advances in scientific understanding, applied with good intentions to make life better. But we now begin to see unintended adverse consequences: climate change and diminishing biological diversity. In the new century, society needs to do a better job of deciding what kind of world it wants to make with the opportunities science offers, rather than just letting things happen. This is a debate about values, with science having no special voice except in factual clarification of possibilities and constraints. But the task is as hugely difficult as it is hugely important. And a large part of the difficulty lies in the uncertainties that are an inseparable part of science at the frontier. It helps to recognize, and explicitly acknowledge, these uncertainties; it hinders further to cloud the uncertainty with emotionally coloured language. ■

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