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The public perception of precaution

In their recent Talking Point articles, Martin Peterson and Andrew Stirling debated whether the precautionary principle could act as a basis for rational decision-making in the face of unknown or unclear dangers (Peterson, 2007; Stirling, 2007). In addition to the problem of measuring the effectiveness of implementation, there is—more fundamentally—little understanding at present of how implementing the precautionary principle can affect the public's perception of risk. This is of special importance considering that, in the absence of clear evidence, the perception of risk often drives a debate and any subsequent requests for a precautionary approach.

Precaution- and risk-taking can be regarded as two sides of the same coin. Precaution-taking, in particular, is best described as the implementation—either temporarily or permanently—of measures intended to prevent harm when risks are unknown, unclear or unproven. Although many international regulatory bodies are still formulating their guidelines for a rational application of the precautionary principle to environmental health, a number of European countries—ostensibly encouraged by the European Commission's communication on the precautionary principle (EC, 2000)—have already implemented policies to prevent potential harm, partly as an approach to deal with public concerns.

Clearly, there is ample controversy about why, when and how to invoke the precautionary principle as a protective measure; however, so far, there has been little attention paid to whether the measures actually achieve the desired effects. Two questions have rarely been addressed by research: do precautionary measures really deliver improved protection and do people feel safer when they know that precautionary measures are in place to protect their health?

Regarding the first question, it is logically impossible to predict the effects of precaution-taking if the nature or presence of a risk is unclear in the first place. Only when subsequent analyses determine that a risk was present is it possible to retrospectively evaluate the precautionary measures that were in place. A report by the Australian Parliament states that "…it has not been possible to estimate or quantify with any degree of accuracy the extent of a safety margin that needs to be prescribed in standards to be properly protective of the risk to the public" (Australia, 2001).

The second question is particularly important because several policies—for example, with respect to mobile phone communication—seem to have been implemented in part to reassure the public. These measures underscore the fact that societal values and the unwillingness of the public to accept risks are crucial factors in determining the desired level of protection. Consequently, factors such as the practical experience of professionals and the risk perceptions of lay people, in addition to scientific data, have been seen as valid contributions when making decisions about precautionary measures.

We conducted two comparably designed experiments to evaluate whether precautionary policies affect the lay person's perception of the level of risk associated with mobile phones (Wiedemann & Schütz, 2005; Wiedemann *et al*, 2006). The first experiment was conducted in Austria ($n = 246$) and the second in Switzerland ($n = 640$)—with support from the Swiss Research Foundation on Mobile Communication (Zurich, Switzerland)—using German- and French-speaking subjects. In both experiments, the subjects who received information about precautionary measures expressed a higher perception of risk than subjects who did not receive the information (Fig 1). These differences were significant in both the first ($p < 0.01$) and the second ($p < 0.05$) study.

These counter-intuitive findings are of particular importance to regulators and policy-makers as they show that disseminating information about precautionary measures does not necessarily decrease risk perception. Instead, they indicate that precautionary actions tend to amplify risk perception,

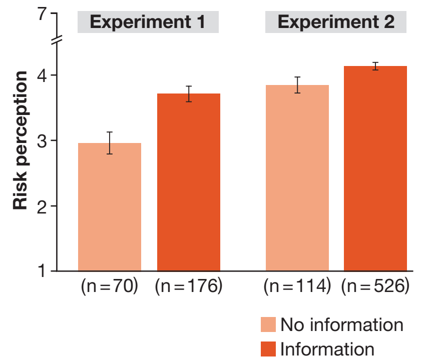

Fig 1 | Mean ratings and standard errors of mean perceived risk for people who do or do not receive information about precautionary measures.

presumably because people perceive the need for implementing precautionary measures as indicators of risk. A British study of public responses to information about the possible health risks of mobile phones found similar results (Barnett *et al*, 2006).

The challenge of drafting precautionary policies in the context of risk perception and social values is not unique to mobile communication; it is also relevant to understanding how emerging technologies and the related public debates—for example, biotechnology and nanotechnology—might be unexpectedly affected by the implementation of precautionary measures. Clearly, the challenge is to communicate the reasons behind precaution-taking so that additional measures are seen as indicators of increased safety, rather than as a confirmation of the existence and seriousness of a risk.

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Holger Schütz & Peter Wiedemann are in the Programme Group MUT at Research Centre Jülich, Germany
E-mail: h.schuetz@fz-juelich.de
E-mail: p.wiedemann@fz-juelich.de
Martin Clauberg is in the Department of Civil & Environmental Engineering and the Institute for Environmental Modelling, University of Tennessee, Oak Ridge, Tennessee, USA
E-mail: clauberg@utk.edu
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Proper science in moist biology

Last year, Geoffrey Chang and co-workers retracted five papers that contained a faulty protein structure prediction—the result of an error in their software (Chang *et al*, 2006). Although the ensuing debates and arguments about this 'great pentaretraction' have slowly dissipated, it is useful to shed some light on the context in which such mistakes occur. We believe that there are fundamental differences in the scientific philosophy and methodology underlying the discussion that cannot and should not be explained by current definitions of good or bad science. This is not exclusive to protein crystallography; it is also typical of other large-scale, high-tech research fields including nanotechnology, systems biology and imaging technologies.

In general, structural biology is a 'hot' research field, involving the constant development of analytical approaches and technologies—combinations of two specific styles of science (Hacking, 1992): classical 'wet' bench work, and 'dry' computational and mathematical work.

Each style of science—wet and dry—represents a framework for getting at the truth, and comes with its own scientific method, distinct protocols, technologies, theories, language and more general 'ways of doing'. Consequently, it is possible to make claims within one style that make no sense from the viewpoint of the other. For example, the claim that "MsbA is a member of the MDR–ABC transporter group by sequence homology" (Chang & Roth, 2001) is the result of an *in silico* comparison of sequences that can neither be performed at the bench, nor understood or proven by wet work alone.

This implies that wet and dry science differ in terms of what their proponents regard as 'proper science'. In an article in *Science*, Chris Miller, from the Howard Hughes Medical Institute (Waltham, MA, USA), wrote that structures are "just models, not data" and argued that the danger lies in "ignoring biochemical results, conventional but logically solid" (Miller, 2007). He was clearly commenting on the pentaretraction from a wet point of view. From a dry perspective, comments about the error were generally less harsh. It is a widely accepted practice—necessary for doing dry science—to trust a model or an algorithm and believe the outcome. Consequently, dry scientists have generally attributed the error resulting in the Chang retractions to bad luck, an honest mistake, or 'much ado about nothing'. Conversely, the wet community has tended to use more harsh terms including: debacle, fiasco, monumental blunder, sloppy science and inexcusable.

In scientific fields such as structural biology, wet and dry styles are becoming increasingly interdependent. As the complexity of their data far exceeds the computing ability of the human mind, scientists have no choice but to trust computer models. This interaction has become commonplace to a level at which claims, technologies and tools are no longer either wet or dry. They can only be understood and used within a new framework or style that we call 'moist' science—an integration of dry and wet styles. Accordingly, moist science creates a new way of doing 'proper science'. Critiques directed at Chang and co-workers exclusively from a dry or a wet point of view therefore cannot fully evaluate the 'properness' of their research, or fully assess the magnitude of any mistakes.

As moist science is a science in the making, some of its technologies are still experimental and protocols have not yet been unanimously accepted. The specific criteria for what it deems to be 'proper science', or what exactly counts as a mistake, have not yet been set. For example, should the code of an algorithm—which in this case created the error—be included in the methods section of a publication, or made available as supplementary material online? This and other questions must be settled in order to reach a new consensus on what constitutes 'proper science'. Therefore, the lesson is not whether to blame, but how to learn from and improve on this new moist scientific style.

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Bart Penders, Klasien Horstman & Rein Vos are at the Department of Health, Ethics & Society, Maastricht University, Maastricht, the Netherlands.
E-mail: b.penders@zw.unimaas.nl
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Philanthropy in Portugal

At the European Council meeting in Lisbon in 2000, the European Union (EU) established the strategic goal of becoming "the most dynamic and competitive knowledge-based economy in the world" by 2010 (Fontaine, 2000). To achieve this, each EU member state would be required to increase its investment in research and development (R&D) to 3% of its Gross Domestic Product (GDP), which would necessitate an increase in both public and private investments.

An important component of private investment is philanthropy. A group of experts recently proposed several policy recommendations to strengthen the role of philanthropy in financing R&D in Europe (EC, 2005). Their report concluded that the EU must further exploit the potential of philanthropy to achieve the strategic investment goals established in the Lisbon Agenda (EC, 2006a).

However, many European societies do not have a well-established philanthropic framework. This is in contrast to the USA and Canada, which have strong philanthropic