Risk communication in precautionary culture the precautionary coalition

JC Hanekamp and R Pieterman

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BELLE Article:

Hormesis, non-linearity, and risk communication

EJ Calabrese

Environmental Health Sciences, University of Massachusetts, Amherst MA 01003, USA

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Introduction

Hormetic dose responses are commonly observed in the toxicological and pharmacological literatures. Using very rigorous a priori entry and evaluative criteria[1,2] reported that hormetic dose responses occurred in nearly 40% of dose responses. Further studies from data sets with more than 50,000 dose responses indicated that the hormetic dose response was far more common than the threshold or linear dose response models. In fact, the threshold and linear models were shown to predict low-dose effects very poorly, whereas the hormetic model performed very well.[2–5] Furthermore, the hormetic dose response is dominant in many areas of the pharmaceutical world including anxiolytic drugs,[6] antiseizure drugs,[7] memory enhancing agents,[8] neuroprotective agents,[9–11] stroke medication,[12] as well as for bone strengthening drugs,[13] erectile dysfunction agents,[13] and for growing hair.[13] The hormetic dose response is, therefore, a dominant dose response within the biomedical sciences, including toxicology. In fact,[14,15] we have now upwards of 8000 dose responses in the hormesis database. These data indicate that the hormetic dose response is very generalizable, being independent of biological model, endpoint measured, and chemical class, or physical agent studied. Furthermore, the largest rodent chronic bioassay (called the mega-mouse study) with over 24,000 animals clearly demonstrated an hormetic dose response for bladder cancer following a detailed assessment by an Society of Toxicology (SOT) Task Force of 14 experts.[16]

Despite the strong performance of the hormetic dose response in the biomedical literature, its use in many of the drugs that humans ingest and its capacity to far outperform the Environmental Protection Agency (EPA) default models in head-to-head competition, the regulatory agencies continue to use the threshold and linear models for non-cancer and cancer risk assessment, while generally ignoring the hormetic dose response. In fact, the EPA and the FDA have used the threshold dose response for decades without ever having validated and vetted the capacity of this model to make accurate predictions in the below threshold zone. The situation exists in which the regulatory agencies refuse to use the hormetic dose response model and continue to use a model was never vetted and one that actually supported an hormetic interpretation. This confusing situation not only affects the field and practice of risk assessment but it also impacts risk communication. Realizing that this is a very dynamic area, at the present, BELLE invited David Ropiek to render his perspectives and opinions of how the concept of hormesis may affect the process of risk communication. A number of experts were asked to develop an independent commentary on the paper developed by Ropiek. Ropiek then was permitted the opportunity to have the final say.

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Correspondence to: Edward J Calabrese, University of Massachusetts, USA. Email: edwardc@schoolph.umass.edu

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BELLE Article:

Risk communication in precautionary culture–the precautionary coalition

JC Hanekamp[1] and R Pieterman[2]

[1]Roosevelt Academy, Middelburg; HAN-Research, Zoetermeer, The Netherlands; and [2]Erasmus University, Rotterdam, The Netherlands

Introduction

The Canadian rock band *Rush*, on their 1984-album *Grace under pressure*, contemplates in *Distant Early Warnings* the worry and fear of the modern world: "An ill wind comes arising Across the cities of the plain There's no swimming in the heavy water No singing in the acid rain Red alert Red alert." Combined with the music, the lyrics make for an ominous song filled with dread about environmental decay and nuclear destruction. This song is an expression of the antithesis of 'progress' of postwar civilization when Western civilization became distressed by stories and facts about pollution and the degradation of nature.[1]

Communicating about risks in a fearful society has proven to be a sustained conundrum. David Ropeik boldly addresses this issue. We fully sympathize with his objective to elucidate the problems thereof; see for example, the works of Breyer and Sunstein.[2,3] These problems come to the fore most forcefully in situations where the public is fearful, whereas most experts think this is unwarranted. Ropeik focuses on hormesis, and that is a special case in this context. In this study, the experts do not just maintain there is nothing to fear but go beyond that and claim that low-dose exposure actually might be beneficial. As Ropeik later shifts his attention to the problems of risk communication more generally, so will we.

However, we would like to focus on the broader context in which risk communication, as described by Ropeik, takes place. We consider this context as a 'precautionary culture,' which we will contrast with "risk culture." In the next section, we briefly describe these two concepts in a strongly contrasting ideal type fashion. For detailed discussions of these concepts, especially the precautionary culture, see the works of Hanekamp, *et al.*[1] and Pieterman.[4,5] This will show that beyond the usual factors that determine specific risk perceptions there is a more general outlook towards potential risks, in which uncertainty and fear take centre stage, see for example, the works of Furedi and Bourke.[6,7] In this climate, a precautionary logic comes to the fore that drives modern societies towards ever more stringent controls which, increasingly, use criminal law to assure compliance, see for example, the works of Garland and Erickson.[8,9]

Everyone who, like Ropeik, wants to promote rational risk policies is up against more than lay risk perceptions. This we shall stress in the third section, which focuses on some social factors that have strongly institutionalized interests in stressing the fearful nature of technology. The classic ideological sources here would be the works of Carson,[10] Ward, *et al.*,[11] and Meadows.[12] All of this bears directly on Ropeik's ideas for more effective risk communication. Although, he is right to stress that affect has to be taken seriously, in a precautionary culture this invites certain strategic problems. In the final section, we offer our own thoughts on how to promote rationality in the ways our society dealt with uncertain threats. For the development of these thoughts, we are indebted to Margolis. See the works of Margolis[13] and Sunstein.[14]

Cultural contours

"Unless we announce disasters, no one will listen."
Sir John Houghton, first chairman of IPCC

Correspondence to: Jaap C Hanekamp, Roosevelt Academy, Middelburg; HAN-Research, Zoetermeer, The Netherlands.
Email: hjaap@xs4all.nl

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During the 20th century, the attitudes towards technology have changed dramatically. In very broad terms, we see a shift away from a positive attitude, which stressed the opportunities for social and personal growth. A very good example of this positive, technology-embracing attitude is the way president Eisenhower presented the plans for the development of nuclear energy.[15] More and more since the 1970s, we find a sceptical or outright negative, distrustful attitude towards science and technology.[16,17]

Living in industrial society, "risk culture", as Beck would have it, governed the outlook on life.[18] Confidence in science and technology and support for their use in industry in order to alleviate society's predominant problem, which is poverty and hunger, is dominant. The logic of wealth distribution on account of economic growth is the primary goal of 20th century public policies, and industry is the tool for its attainment. Certain problems with industrial production are acknowledged and tackled, but the principal goal remained growth. Goklany describes this well in his *Clearing the air*, which shows that already around 1850 we find the first protests against air pollution *and* the first policies that try to do something about it.[a]

The issue of workman's injuries, an important aspect of industrial growth, was increasingly dealt with in insurance schemes. In fact, insurance is a crucial characteristic of risk culture. It shows, for instance, our trust in (actuarial) knowledge. More importantly, it shows our acceptance of the occurrence of accidents. By creating insurance schemes society acknowledges that it is impossible and undesirable to prevent all accidents. Instead, their occurrence is accepted provided that the victims can be compensated for their damages. It was left to the captains of industry to fine-tune their production to the optimal balance of compensation and prevention. Economic rationality, therefore, was a crucial component of the risk culture. The major problem in this context was the incorporation of external damages into the industrial production schemes and their insurance back-ups.

Strong overall economic growth created the opportunities for the development of the welfare state. We have to acknowledge that different nations created welfare regimes with different mixes of private and public insurance schemes. Nevertheless, during the 1960s western industrial societies largely solved the basic problems of poverty. Simultaneously, life expectancy grew as for instance life became safer. Fewer accidents happened, and the dwindling amount of victims (relative to the "Dickens period") were compensated for their damages progressively more expansively. As accidents became less frequent they also became less acceptable. People moreover became accustomed to the fact that they were not individually held responsible for their mishaps. On the contrary, the industrial and social "system managers" were increasingly held responsible for accidents which they should have foreseen and prevented.

In modern western societies, as material needs are met for most people, the logic of wealth distribution that has shaped the Western world, loses its immediate relevance, subsequently assenting to the logic of risk distribution.[20] A society in which citizens are privileged to enjoy and value their health, wealth, safety, security, and longevity paradoxically becomes gripped by the hazards and potential threats unleashed by the exponentially growing wealth-producing forces that mark the later stages of the modernization process.[21] As Beck asserts: "The driving force in the class society can be summarized in the phrase: *I am hungry!* The collective disposition of the risk society, on the other hand, is expressed in the statement: *I am afraid!*"[22] Industrial society with its risk culture thus, developed into risk society with, is our contention, a precautionary culture. With the rise of risk, society came across a different attitude towards industry and technology: the solution became the problem.[23] What is more, ecological tenets gained prominence.[24]

Concomitantly, in economically and industrially highly developed societies, diverse regulation of a mainly precautionary nature has found its way into many areas. The precautionary principle has been incorporated in more than 50 multilateral agreements. See the works of Trouwborst[25] and Stern and Wiener.[26] Societies' shift to a culture of precaution galvanizes citizens' insistence on *advance proof* that activities and products pose no risk to human and environmental health, especially in the long term. Uncertainty has become central. Not so much science, but available scientific knowledge becomes the bone of contention in contemporary culture. Then again, scientists are quite aware of the limitations of scientific knowledge. Within science verification is beyond our capabilities. Indeed, examples abound in which science comes up with surprising new insights overturning old ideas and concepts. In the celebrated BBC documentary *The Ascent of Man*, Jacob Bronowski memorably assessed what science in fact *is*:

[a] In fact, Goklany goes so far as to claim that when in the 1970s federal agencies became active, the problem of air pollution had been solved for the most part by local and state initiatives.

> "… Science is a very human form of knowledge. We are always at the brink of the known; we always feel forward for what is to be hoped. Every judgment in science stands on the edge of error and is personal. Science is a tribute to what we *can* know, *although* we are fallible. In the end, the words were said by Oliver Cromwell: "'I beseech you, in the bowels of Christ, think it possible you may be mistaken."

When we expand our demands for safety, as precautionary culture does, into a by definition *unknown* distant future, the confines of even our best scientific knowledge will surface progressively more poignantly. Here, we enter the realm of uncertainty. And scientists warning about what can go wrong are much more trustworthy then scientist that try to tell us there is very little chance for worst-case scenarios.[27]

In this context, the precautionary principle is developed. There are almost as many definitions of this principle as there are treaties that incorporate it. However, for the sake of brevity and clarity we can state it in the following fashion, which stresses the characteristic triple negative formulas most often used: uncertainty about possible damage is not a valid reason to abstain from or postpone protective action. This principle is the ideal type expression of the "better safe than sorry" attitude, which Ropeik and many others find so worrisome. An integral part of the attitude that promotes this principle is the statement that "absence of evidence is not evidence of absence." This statement – which is a logical truism and therefore empty – offers the rationalization for the continuance of fear even when an extensive search for empirical evidence has not been successful.[b]

Proposals like the ones Ropeik puts forward can be described as attempts to promote the attitudes of the risk culture against the presence of precautionary attitudes. By framing Ropeik proposal thus, we stress that there is a much broader context, which influences the risk communications about specific issues than affect heuristics. We do not claim that today the precautionary culture is overriding. We do claim, however, that it is a cultural repertoire that is readily available to be used by those who have an interest in doing so. This is the topic of our next section.

[b] It is interesting that both left wing ecologists and right wing security hawks are equally prone to using this rationalizing device.

Vested interests in fear and precaution – the precautionary coalition[28]

From the 17th century onwards, the long experience in the western world with the concept of balancing powers within society teaches us that opposing forces in society should not be trusted on their intentions, but on their constructive societal results. Coldly stated, there is no reason to trust the advocates of the precautionary approach beforehand because we trust the cautious scientific community and environmental Non-governmental Organization (NGO) or distrust the business community and governments. As the precautionary principle is put forward as a counterforce to the hubris of science and business interests then who are its adherents?

We can first ascertain that uncertainty, even distrust, has become an important source for scientific investigation as such. Today, there are a vast number of academic disciplines that focus on the problems man produces through science, technology and industry. Rachel Carson, or indeed the Club of Rome could not have foreseen this tremendous increase in the number of concerned scientists having a professional career focused on elucidating the impact of man on the planet. However, it is not only at the level of academic studies that the focus on technological risks has gained prominence. All those academics hold positions in institutions that are expressly created to further the social, political, and economic awareness of the problems technology poses for our environment and our health. One particular example is the European Environmental Agency, which published *Late Lessons from Early Warnings*, in which, among many other things, it was remarked about chemical technology that "… their very novelty might be taken as a warning sign."[29]

In order to be accepted among fellow professionals, within such institutional context, individuals have to take their duty to warn against possible problems – that could be potential disasters – very seriously. They similarly have an interest in keeping their job and in promoting the interests of their organization. We do not mean to say this is *all* manipulative strategic action, far from it. Because of their training, their self-esteem and their job satisfaction the scientific professionals in these organizations *must* believe that what they do is essential to the welfare of society. In other words, their professional convictions are truth-conducive. On belief-formation, see the works of Jones[30,31] and Williams.[32]

One of the drivers of such organizations is to point to a constellation of vested interests, which

influence the debates on truth.[c] Obviously, as far as such analyzes are valid, they apply equally to the precautionary coalition of which environmental and consumer NGOs, apart from sections of the scientific community, are important contributors. They have their own political agenda. The precautionary principle has given NGO's a weapon to fight against business corporations that might be subdued by precautionary-inspired environmental legislation. Consumer organizations are, by their nature, obliged to find potential harm caused by technology; it is their *raison d'etre*. They have been successful in cultivating their image as champions for the good society. This sometimes obscures the fact that, like any other organization, their first interest is their own continued existence. This means they need a steady cash flow. Consider, from this perspective the following quote from the www.wwfplush.com Web site: "Passionate, optimistic, credible, and inspiring. That's what the WWF Plush Collection stands for. When you buy these beautiful animals, you contribute to a future in which humans live in harmony with nature."[d]

A third party in the precautionary coalition are supranational political bodies. Through the politicization of the European consumer, with the introduction of accountability as the market was deregulated in the 1980s with the obvious loss of political power of the nation state, European Union (EU) governments (re-)established their legitimacy.[34] Through the institutionalization of uncertainty and mistrust, regulation of an in essence deregulated market was established. The insistence on advance proof, with the aid of the precautionary principle, that products are safe galvanizes consumer-suspicion even further, for which increasing amounts of regulation is required. Finally, the mass media is a key coalition partner as it is well-equipped to find stories of harm, guilt and blame. The distrust of technology and science has grown into a profitable business. As Forbes remarks in relation to the Bovine spongiform encephalopathy (BSE)-episode in the UK: "Fears about the safety of beef bloomed like so much algae under the heat of the *Sun* and other media exposure."[35]

From this and the previous section, we can observe that the kind of risk communication Ropeik tries to promote is up against strong countervailing powers. Even with the best of intentions and supported by strong scientific consensus, people who want to make sure that "the facts" get a fair hearing, have more to worry about than citizens who are disinclined to believe them. The starkest example of this is the treatment of climate skeptics and Chief Executive Officer (CEOs) of the oil and energy companies. Because the science is supposed to be settled, there are those who try to bar the skeptics from participating in the public debate. For the same reason the CEOs of companies like Exxon are branded for financing misinformation. National Aeronautics and Space Administration's Jim Hansen, in a statement to the House Select Committee On Energy Independence And Global Warming, has gone so far as to affirm that these 'CEOs of fossil fuel energy companies know what they are doing and are aware of long-term consequences of continued business as usual. In my opinion, these CEOs should be tried for high crimes against humanity and nature.'[36]

Admittedly, this is an extreme example yet it is precisely in such impassioned contexts that Ropeik's proposals for effective risk communication are important. In the next section, we explain some ideas, which we feel are important in this respect.

Some thoughts on effective risk communication in a precautionary culture

Ropeik rightly stresses the need to take subjectivity seriously when the goal is to defuse heated debates on environmental and health problems generated by technology. It will not do to just try to get the "bare facts" across. We think Ropeik's concrete proposals are valuable, but we also contend that the problem he discusses is fundamental. Not only do we need to consider the points we made above. We also think there is a real dilemma here, regrettably one that in general cannot be solved in straightforward terms.

We like to put this dilemma in the following way. Hemocratic governments are obliged to take their citizens seriously. This is true even when the citizens are "irrationally" afraid for things that all experts agree are not dangerous at all or at least much less dangerous than people usually think. For a number of reasons – one being political suicide and another paternalism – it will not do to just tell

[c] See for example, the letter from The Royal Society to Exxon Mobile of the 4th of September 2006 in which Exxon was urged to stop funding research that might result in perspectives opposed to the "consensus on climate change."

[d] In a Dutch advertisement showing a close-up of a polar bear's head, the WWF, in collaboration with a major department store, this collection is promoted with the following text: "It is now or never for the North pole. Buy your favorite polar animal from the WWF plus collection now and contribute to a white North pole."

the public "not to worry". On the other hand, however, democratic governments have a duty – often inscribed in law – to provide as much good for society as it can generate from the public means. The duty of wealth distribution is a strong driver of many public policies in diverse fields. These two duties in not a few instances do not match up. Margolis terms this conflict persistently as "expert/lay controversies."[13]

Margolis' book was published over 10 years ago and tells us that this kind of controversy tends to persist for a long time. Take for instance the fear for Electromagnetic Field (EMF) radiation, which are transmitted by radar and power lines, computer screens, and Universal Mobile Telecommunications System (UMTS) masts. For an extensive discussion and analysis of this issue, see the work of Burgess[37]. Billions have been spent on research, and the science remains clear: the feared health problems are not associated with this kind of radiation. Nevertheless, precautionary proponents usually succeed in convincing new groups of people to be afraid of new EMF sources. What we witness here is a continued contestation over the "truth" as part of a power struggle, which also is an ideological struggle.[38]

At one side of the ideological rift we find Ropeik, Margolis, and many others, including the authors of this contribution. They are rooted in industrial society and its corresponding risk culture. The primary societal goal, thereof, is development and growth. In order to bring that goal closer, this side of the debate stresses that we need to take the best available scientific knowledge seriously in order not to misspend public funds. On the other side, we find people firmly rooted in risk society and precautionary culture and strongly convinced of the crucial importance of ecological tenets and goals. They are the ones who will stress the importance of taking the public fears seriously. In recent proposals for new forms of governance, transparency and participation are stressed, and the expert/lay distinction is disqualified: experts are handicapped by the fundamental limits of specialized and fragmented science, and lay people's knowledge is praised as that of "user experts." This kind of attitude can be labeled "subjectivity realism."[e] With reference to the classic Thomas theorem, the subjective realists stress that when people think something is real, it will become real in its consequences.[39]

Incontrovertibly, the most critical and most volatile problems cannot be solved without the effective marshalling of expert scientific knowledge and judgment. We should not include lay knowledge into science, peer review or anywhere else. These are in fact opinions that need to be interrogated just as much as scientific evidence itself. "We owe a debt to those who, in the past, were prepared to put their heads above the parapet of perception, prejudice, and power, in order to expose the real workings of the world. This was not done by accommodating to majority, or even minority, views."[40] This is not to say that science has a monopoly of some sorts or another. As Noam Chomsky puts it: "Science is tentative, exploratory, questioning, largely learned by doing. One of the world's leading physicists was famous for opening his introductory classes by saying that it doesn't matter what we cover, but what we discover, maybe something that will challenge prevailing beliefs if we are fortunate. …"[41] Therefore, the only way out of the conundrum we sketched above is to reiterate the values of knowledge, information, education, ethics of responsibility, and the individual capability of judging freely.[42]

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BELLE Article:

Risk communication and non-linearity

D Ropeik

Risk Communications, Harvard School of Public Health, Harvard Center for Risk Analysis, Boston, MA

This article will consider non-linearity and hormesis from the perspectives of risk perception and risk communication. The observations that follow do not come from a scientist or researcher. (For a richer academic treatment of the issue of risk communication and nonlinearity, see BELLE, Vol. 11, Issue 1, 2002). I was for 25 years a journalist on television and in print, focusing on coverage of environmental issues. I then studied and taught risk perception and risk communication at the Harvard School of Public Health. I now independently consult in these areas. From the academic side, I have read a fair amount of the literature that helps explain what I call 'The Perception Gap,' the gap between our fears and the facts. And as a journalist and consultant I have witnessed in the real world, people's relatively greater fear of lesser risks, and relatively lower fear of the risks the scientific data suggest they ought to worry about more. I offer the following perspectives based on those foundations.

Introduction

The idea of non-linearity/hormesis has a problem. The suggestion that low doses of infamous toxins might not be harmful, and may in fact stimulate effects that are positive, will be difficult for many to consider with an open mind. The idea of hormesis will be difficult for the public to accept, because it conflicts with the way they have always thought about what is safe and what is dangerous.

Accepting the idea that a little of a bad thing might not be bad, and might even be good, raises the possibility that it might be okay to be exposed to DDT or dioxins or a host of other supposedly dangerous substances. The scientific facts of non-linearity/hormesis may prove that such exposure is safe. Nonetheless, the idea of that exposure *feels* threatening, the facts notwithstanding.

Those who promote non-linearity/hormesis will not carry the day merely by arguing the science. This will not just be a matter of toxicology and the facts. Non-linearity is about things that can harm us, or kill us, and that evokes powerful affective triggers by which we protect ourselves from such threats. The perception of risk is a combination of rational fact-based analytical thinking *and* affect. Incorporating an understanding of and respect for this affective component of risk perception is critical to more effective risk communication. And effective risk communication will have a lot to do with whether non-linearity/hormesis is able to move from academe into the toolkit of policy makers.

Risk perception

Let's say you will die tomorrow, but you have your choice of how. You can die of cancer, or heart disease. Which do you choose?

Let's say you work in a hospital and the government asks you to be vaccinated against smallpox, in case it is used as a weapon by terrorists. There haven't been any small pox cases for more than 30 years, however, and the vaccine carries a one-in-a-million risk of killing you. Do you take the shot, which involves taking a chance that you might die, in exchange for apparently no benefit? How about if there is one confirmed case of smallpox in a hospital somewhere in your country? Now the vaccine confers a benefit, although it still might kill you. Do you want the vaccine now?

Let's say you are planning to travel tomorrow by plane, but suddenly all the news channels show dramatic video of an airplane, hijacked earlier in the day from the airport you fly from, that has gone down in terrible fiery crash that kills more than

Correspondence to: Director, Risk Communications, Harvard School of Public Health, Harvard Center for Risk Analysis, 718 Huntington Avenue, Boston, MA 02115.
Email: dropeik@hsph.harvard.edu

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200 people. There is an interview with a survivor, partially burned, who describes the horror of the crash and fire from which she escaped. Your full trip tomorrow will take 3 h by plane, including airport time, and 4 h by car. Do you consider driving instead of flying?

If you are like most people in the classes I teach to mid-career professionals, in regards to the first question, you would prefer to die of heart disease rather than cancer. But wait. That is irrational. You should be more worried about heart disease, which kills roughly 20% more people in America each year, in roughly the same demographic groups.

Would you take the smallpox vaccine if there are no cases anywhere, a one-in-a-million risk for zero benefit? Most people say no. Does your choice change if there is one case somewhere in your country? Under those circumstances, the overwhelming majority of my unscientific sample switches from 'No thanks' to 'Yes, Please!'. Again, from a numbers perspective, that choice does not seem rational. The risk of death from the vaccine is one in a million in both cases.

Might images of a hijacked plane killing hundreds in a fiery crash alter your travel plans? It did for thousands of people in the United States after the terrorist attacks of September 11, 2001. By many metrics, flying declined and driving increased in the months after those attacks. Separate analyses by the University of Michigan Transportation Institute, and a team of researchers at Cornell, found that for the period of October-December 2001, roughly 1000 more people were killed in motor vehicle crashes than would be expected for those months.[1,2] In terms of making themselves safer, people who chose to drive were statistically wrong…irrational. In general, flying is safer than driving. But their perception of risk was informed by factors well beyond just the statistics, and for many, their perceptions proved deadly.

Why do we make such irrational judgments about the risks we face, experts and lay people alike? Why do some risks *feel* more worrisome than others? Why do not we just use the facts to make our decisions? The answers to these questions are directly relevant to public acceptance of, or resistance to, non-linearity/hormesis.

Nearly 40 years of investigation in the field of risk perception has established with research what most of us realize intuitively, that risk means different things to different people.[3] Why? A proposed answer was put forward by Melissa Finucane and colleagues, who wrote "Representations of objects and events in people's minds are tagged to varying degrees with affect." These "…positive or negative affective feelings guide judgment and decision-making." They name this 'The Affect Heuristic.'[4] Simplified, risk is a matter of the facts *and* our feelings.

But while the affect heuristic describes why two people can see the same risk differently, it is a blunt instrument for risk communication. It only tells us generally that our feelings play a part in how we choose. It does not tell us specifically where our positive or negative affect comes from. It does not illuminate the underlying characteristics of risks which make some feel more frightening than others.

In order to communicate more effectively about risk, we need to speak and act in ways that are relevant to how people feel about that risk. So we need to know the specifics of affect… where do those positive and negative feelings come from... why are some risks scarier than others? I attempt to embody that approach in the following definition of risk communication:

> *Actions, words, and other interactions, that incorporate and respect the perceptions of the information recipients, intended to help people make more informed decisions about threats to their health and safety.*

For effective risk communication, I suggest that we need to understand why people feel about risk the way they do, and respect that those feelings play an integral part in the process of judging how to protect ourselves. Risk perception which is not solely fact-based simply can not be dismissed as 'irrational.' People who worry more, or less, than the scientific information suggests, are neither wrong nor right. They are trying to survive. It seems perfectly reasonable to use the facts you have, *and* values and emotions and anything else you can, to make sense of a threat.

A range of research supports this perspective. As Herbert Simon's concept of 'bounded rationality' proposes, the ideally rational actor is a myth.[5] Simplified greatly, this idea proposes that we almost never have all the facts, and/or all the time, and/or all the intellectual resources necessary for perfectly rational decision making. But decide we must as we live our lives one moment to the next. Heuristics, or 'mental shortcuts,' are what we use to bridge the gap between what we know and the decisions we have to make.

Important contributions confirming this view, and identifying some of the specific heuristics we use, came from research by Daniel Kahneman, Amos Tversky, and others.[6] Kahneman, *et al.* identified several heuristics that are relevant to perception

of non-linearity/hormesis. I will discuss several of these in more detail below. (Kahneman won the 2002 Nobel Prize in Economics for this work. Tversky had passed away and the award is not granted posthumously.)

Even more specific insights into risk perception come from psychometric research by Paul Slovic, Baruch Fischhoff, Sarah Lichtenstein, and many colleagues. That work has identified a set of general characteristics that seem to make some risks more worrisome than others.[7] Several of these risk perception characteristics and their relevance to non-linearity/hormesis are also discussed below.

A third field that speaks to the roots of affect is the 'Cultural Theory of risk' as put forth by Mary Douglas and Aaron Wildavsky.[8] This view, more anthropological and less empirically established, posits that people's perceptions of risk are produced by, and support, social structures. In essence, what group(s) you belong to, your role in those groups, and how strongly you feel you belong, are important factors in all your worldviews, including your perceptions of risk. Cultural theory identifies four distinct group identifications that inform risk perception. Individualists (low group identity, less concerned with their role within their group…confident that natural systems will reduce many risks), Egalitarians (high group identity but don't feel circumscribed by their place in society…greater concern about low-probability high-consequence risks that threaten the whole group) Hierarchists (high group identity and feel constrained by social expectations…rely heavily on experts to tell them what to be afraid of), and Fatalists (don't identify with any group but feel constrained by behavioral expectations…passive about many risks since they feel they can't do much about them). I note the contribution of Cultural Theory here, but do not go into detail, because I think it offers insufficient precision as a tool for risk communication.

Here then are some of the general heuristics and specific risk-perception characteristics, which might be relevant to public acceptance or rejection of non-linearity/hormesis.

The availability hueristic

The more available to our consciousness is information relevant to the choice we face, the more affective influence that 'background' information will have on our decision.[9] As a simple example, news coverage creating elevated awareness of avian flu makes many people more concerned about avian flu than about 'regular' influenza, which is less in the news.

Availability can, in some ways, be thought of simply as awareness. Awareness can come not only from the information media, but any other source. If you arrive home one evening and someone in your family tells you about the crime she saw on a nearby street corner, you are likely to feel that crime is more likely on that street corner than you thought it was before you got home. Viral marketing (using existing social networks to exponentially increase awareness of a product or service)[10] and the social amplification of risk (social factors amplify or dampen perceptions of risk and create secondary risks in how people behave in response to the initial threat…[11]), both rely heavily on the availability heuristic.

Temporally, availability can be current or latent. That is, we are influenced by what is currently before us, but we also rely on what we already know. If we have had a frightening experience during a plane flight, we will probably be more concerned about flying, regardless of whether a plane crash is currently making news (*and regardless of the statistical facts about flying safety*). If we have learned that some industrial chemicals cause cancer, ready access to that background awareness will inform the judgments we make about such chemicals.

I believe that latent availability bears directly on the risk communication challenge facing proponents of non-linearity/hormesis. There may not be anything in the news about toxins, but most people already have at least a basic mental library of information about toxins, in general, and about some specifically. If you say 'DDT' to most people, they are like to have some latent awareness on which a very quick and not entirely fact-based judgment will form in their minds. Just the word 'pesticides' is threatening to many, based on what they have read and heard, the facts notwithstanding. Based on my 25 years as a journalist who focused on environmental stories, I can say with confidence that many people are afraid of substances they think are toxic regardless of the actual, that is, scientifically calculated, risk. Their latent availability on such issues is why, to some degree, low doses are unacceptable.

Imagine then the difficulty of convincing people that low doses might not be harmful, and in some cases may actually be beneficial. The idea of non-linearity/hormesis is likely to encounter resistance because of this availability heuristic.

The representativeness heuristic

Under the conditions of bounded rationality, an event is judged more likely "…to the extent that it

represents the essential features of its parent population or generating process…."[12] Simplified, when we don't have all the facts, or the time, or all the intellectual capacity to rationally analyze a choice, we fit what we information we do have into the patterns with which we are already familiar. Imagine a football player. Is it more likely or less that he is bigger than you? Imagine a politician. Is it more or less likely he is honest? You don't have the facts, but you have patterns of information on which to base your choice.

If you were to ask most people to make a judgment about whether a toxic substance is dangerous at a low dose, few if any would have all the facts. But they will have a pattern of information about the class of such substances – it's parent population – that they will apply to making their judgment.

This too is likely to cause resistance to the idea of non-linearity/hormesis. Based only on my experience reporting on environmental stories, people lump together any substances that can cause cancer. The dose, the route and the time period of the exposure, and the type of cancer does not matter. Carcinogenic substances belong to a class that has certain general characteristics, and by considering the general characteristics, those substances (and the way they are studied) will be categorized.

Non-linearity/hormesis proposes that though many potentially carcinogenic substances have similar general characteristics – many are mutagenic, most are invisible, odorless, tasteless, manufactured, associated with painful death – that each must be considered individually. Non-linearity argues that the blanket assumption that the only safe dose for carcinogens is no dose, is too simplistic. Perhaps it could be so, based on a growing body of scientific evidence. But not in the patterns we non-toxicologists apply to such substances as we subconsciously judge what to be afraid of and how afraid, or not, we should be.

Non-linearity also proposes that, for non-carcinogens, below the threshold dose at which no observable adverse effect occurs, a substance may stimulate activity in an organism that may be positive. That is also a new way of thinking about such substances, outside the background patterns we apply to figure out what to think and how to feel about things that threaten us. 'One in a million is too high,' people in my stories would often say. 'The only safe dose is no dose.' Not according to the facts as proponents of hormesis see them perhaps, but certainly that is how the public categorizes such substances.

The research by Kahneman, *et al.* identified general heuristics for making judgments about the *probability* of events. While they can (must) be applied to the understanding of risk perception, I suggest that another field offers a more precise explanation for the emotional components of the affect heuristic. This is the study of risk perception, pioneered by Paul Slovic, Baruch Fischhoff, Sarah Lichtenstein, and others, which goes beyond just how we judge probabilities. This research has identified specific affective characteristics of potentially threatening circumstances which shape our subconscious 'decisions' about what to be afraid of, and how afraid to be. These risk perception characteristics go a long way toward helping us understand public attitudes toward risks and, therefore, help predict how people are likely to respond, affectively, to the idea of non-linearity/hormesis.

In my view, relevant risk perception characteristics include the following.

Trust

If trust is low, fear is likely to be higher, and vice versa. A friend of mine, a college educated Democrat, said "I used to think avian flu was a big risk, but now that Bush says it is, I'm not so sure." Trust can be a matter of who is communicating about the risk, but it can also be a matter of how much people trust the competence and honesty of the agency that is supposed to protect them, or how open and honest is the process by which risk policies (e.g. acceptable threshold doses) are made.

As this pertains to non-linearity/hormesis, if neutral experts communicate about this new approach, or if consumer or environmental groups do, the same information is likely to be more trusted and cause less worry than if the communication comes from a scientist who is a known advocate on one side or the other, or if the information comes from industry, or from a scientist supported by industry money.

This bears emphasis. The more the scientific work on non-linearity/hormesis is supported by industry, the greater will be mistrust among the press and public. The stereotype that money always corrupts is ludicrously unfair. (The problem, of course, is that money does corrupt science just enough to raise these blanket suspicions.) And the assumption that consumer and environmental groups are pure of bias is naive. But these perceptions are real, and based on trust, which is one of the most powerful elements of our affective decision making. It is vital for anyone communicating about nonlinearity/hormesis, or any risk, to recognize and respect the importance of trust.

Choice

When a threat is imposed, it causes more worry than when the same hazard is engaged voluntarily. The substances under scrutiny in toxicology and risk assessment are, for the most part, substances over which we have little choice. They are in our food, air, and water, and we effectively have no say in whether we will be exposed, or at what levels. These potentially threatening agents are imposed on us. The suggestion that they might not be harmful, or might even be beneficial, will likely encounter resistance from anyone who, like most people, worries more about any risk that is imposed.

Natural or human-made

The work of Slovic, Fischhoff, *et al.*, has found that most people are more afraid of a risk that is human-made than a similar threat that is natural. For example, many people are more afraid of nuclear radiation than solar radiation, even though nuclear radiation is estimated to have caused 500 cancer deaths among more than 80,000 survivors of Hiroshima and Nagasaki over 60 years,[13] while solar radiation causes approximately 8000 melanoma deaths in the United States per year.[14] The substances investigated by toxicology are mostly human-made. They are *by nature* more worrisome. Again, this bodes poorly for open-minded acceptance of non-linearity/hormesis.

Dread

This factor offers an explanation for why most people fear dying of cancer more than heart disease. In simple language, the more painful the consequences of a threat, the more fearful it seems. Most of the people in the courses, I teach and audiences I speak to, perceive cancer as a more painful way to die than heart disease. This probably helps explain why the United States has a declared 'War on Cancer' but not an official 'War on Heart Disease.' In 2004, the National Cancer Institute had a budget of $ 4.7 billion.[15] In 2002, cancer killed 557,271 Americans.[16] That same year, heart disease killed 696,947.[16] Yet in 2004, the National Heart, Lung, and Blood Institute spent approximately $1.8 billion on all cardiovascular diseases.[17] The public demands more protection from threats that are more frightening because they involve more pain and suffering. This is yet another reason, and probably an important one, why many people are likely to resist the idea that a little dose of a cancer-causing agent may not cause cancer, and may even be beneficial.

Uncertainty

This is a simplified term for what the research refers to as 'knowable vs unknowable.' Can we see, taste, and sense it in some way? Do we know who or what might harm us, where, when, how? Does science have all the answers (or at least most of them)? Does science have the answers but we cannot understand them? If the answer to any of those questions is no, our ability to be rational is severely bounded, and we are likely to turn more to precaution as protection. Uncertainty is pivotal to the entire concept of the precautionary principle.

The substances considered by non-linearity/hormesis fit many of the characteristics of uncertainty. They are almost always beyond our conscious senses. We are exposed to many of them in ways of which we are unaware. Honest scientists acknowledge the uncertainty of their analyses of these substances. And most people, including myself, do not have the intellectual background and capacity to fully understand what science *does* know. For many reasons, there is a lot of uncertainty about these substances, and that is yet one more reason why non-linearity/hormesis will be difficult for many to accept.

A few qualifications on the above list.

- It does not claim to be comprehensive. It is one person's selective summary of *some* of the heuristics and risk perception factors that relate to the risk communication challenge facing advocates of non-linearity/hormesis.
- These heuristics and risk perception characteristics seem to be generally applied by most people. But on top of those general 'rules of thumb,' our decision making also relies on the experiences and life circumstances that make each of us unique. So the factors listed can only be a general guide to people's perceptions of risk.
- Though they are listed separately, several of these factors are usually relevant to any given situation. Rarely is one heuristic or perception factor the sole determinant of affect, though frequently, one or two predominate.
- How these factors bear on risk perception is dynamic. As facts and circumstances change, each of these factors may be more or less powerful in shaping affect. Think of them in the metaphor of a set of scales or a seesaw.
- In the simple terms of 'How afraid are you?,' I suggest these factors move perceptions one way or another but do not make them absolute. That is, they make us more or less afraid but not absolutely terrified or totally unafraid. They

impact our perceptions in shades of gray, not black and white.

Risk perception as a tool for risk communication

As stated earlier, knowing why people feel the way they do is the first step toward respecting their perceptions. That, in my view, is a prerequisite for the honest respectful dialogue vital to effective risk communication. But if you ask 10 practitioners of risk communication to define it, you will get that many different definitions. As a 1986 summit of leaders in the field reported, "…there is no single overriding problem and thus no simple way of making risk communication easy."[18] So while the following perspectives offer general guidance on risk communication as it relates to non-linearity/hormesis, I do not claim they are definitive. They are offered as suggestions.

• Include risk communication in decision making. Far more is communicated to people by what you do than what you say. "Risk communication… must be understood in the context of decision making involving hazards and risks, that is, risk management."[18] Information that affects how people think and feel about a given risk issue is conveyed in many of the management actions that an organization takes on that issue.

This means that risk communication should not be thought of as merely which words to use after policies are set. Risk perception and risk communication need to be incorporated at the decision-making level of organizations, which means that *organizations should include risk communication in the job responsibilities of senior managers, not just of the public relations or communications staff*. As the NRC report finds, 'Risk managers cannot afford to treat risk communication as an afterthought,' that comes at the end of the process after risk assessment has been done and policy set.[18]

This particularly matters if risk communication is to build on the importance of trust. People measure the trustworthiness of a person or organization in all of what he/it does. So decisions on things like which financial support to accept, who to include on a board of advisors, how strident to be in one's advocacy, all help determine how trustworthy you will or won't be perceived. The more trustworthy, the more influential you are likely to be as a risk communicator.

• Trust is fundamentally important for effective risk communication, and it is on the line with everything you do. As important as trust is to the communication of non-linearity/hormesis, it merits consideration in more detail.

As Bennet and Calman observe, trust is determined in part by *who* does the communicating. "… messages are often judged first and foremost not by content but by the source: 'Who is telling me this, and can I trust them?' If the answer to the second question is 'no,' *any* message from that source will often be disregarded, no matter how well-intentioned and well delivered."[19]

When the anthrax attacks took place in the fall of 2001, the principle federal spokespeople were the Attorney General, the Director of the FBI, and the Secretary of Health and Human Services (HHS), and not the head of the CDC or the U.S. Surgeon General, doctors likely to be more trusted than politicians. A survey by Robert Blendon, *et al*. of the Harvard School of Public Health, 10/24-28/2001, found that 48% of Americans would trust the head of the CDC as a source of reliable information in the event of a national outbreak of disease caused by bioterrorism. But only 38% would trust the Secretary of HHS, and only 33% would trust the Director of the FBI.[20] Had risk communication been considered by senior managers as the anthrax issue was beginning to develop, it would have been wiser to have the more trusted officials do the majority of the public speaking, which might have done more to help the public keep their concern about the risk of bioterrorism in perspective.

But trust is more than who does the talking. Trust is also heavily dependent on honesty. Honesty means many things, of course. As it pertains to non-linearity/hormesis, it means the advocates would be wise to temper their support for the idea with equivocation, and opponents should temper their resistance with openness. Absolutes are less trustworthy *per se*, and certainly create problems for trustworthiness when evidence develops that what you claimed is absolutely so, isn't. If evidence doubts the idea of non-linearity/hormesis, advocates should honestly acknowledge that information. If evidence supports the idea of non-linearity/hormesis, opponents need to acknowledge that evidence. Consider the statements of two prestigious science bodies on non-linearity and low dose radiation in 2005.

A news release summarizing the 2005 report from the National Academies of Science, "Health Risks from Exposure to Low Levels of Ionizing Radiation: BEIR VII Phase 2," quoted committee chair Richard R. Monson, associate dean for professional education and professor of epidemiology, Harvard School of Public Health, as saying "The scientific research

base shows that there is no threshold of exposure below which low levels of ionizing radiation can be demonstrated to be harmless or beneficial."[21] That is dangerously unequivocal, despite reasonable evidence to the contrary, as cited by the French Academy of Sciences just 3 months earlier. Consider the couched way that report summarized the issue. "…the use of this (linear no-threshold) relationship to assess by extrapolation the risk of low and very low doses deserves great caution."[22] Someone agnostic on the issue might judge the cautious statement of the French more honest than Professor Monson's certainty.

• Involve all sides to an issue in advisory groups or other mechanisms as the issue is being considered. This speaks to the importance of choice. Give people a say in their fate. Create mechanisms to provide input for relevant stakeholders. This is an important way to follow the widely-accepted recommendation that risk communication is more effective when it is an interaction, not a one-way process.

This input role must be more than perfunctory. Many government public hearing processes allow people to speak, but proscribe officials conducting the meeting from answering the public's questions and concerns. Such an interaction fails to give the audience a sense of control, and more, can destroy trust since it seems disingenuous to claim to want public input but then not acknowledge it with at least a reply.

• Acknowledge and validate the affective component of people's risk perception as you speak to them. Dialogue begins before you say the first word. Dialogue begins with acceptance of the realities of people's feelings, although their perceptions may seem to fly in the face of the facts. If you don't respect people's feelings, and try to make them understand the facts as you see them, you won't sound like you are trying to help them make an informed choice. You will sound like you are trying to convince them to make your choice. Their receptivity to your messages will likely be reduced. When you do respect their affective perceptions, and say so, receptivity to what you have to say will increase.

Advocates of non-linearity might consider saying things such as "I know it sounds really hard to believe based on everything we have learned about DDT up to this point, but…" (insert description of hormesis here). This acknowledges the availability and representativeness heuristics. Or they might say "The way we assess the risk of these substances is designed to protect us from cancer, and as awful and painful as cancer can often be, we all want to use the most precautionary way to protect ourselves. I do too. But… (insert description of non-linearity here). This acknowledges our intrinsically greater fear of threats that can cause more dreadful outcomes.

The important thing in the above examples is not the semantics. Note that the first thing said is an acknowledgement of the way people feel, not a factual argument in favor of your point of view.

• Finally, for effective risk communication, research people's perceptions of nonlinearity/hormesis as much as you research the toxicology and epidemiology.

"We wouldn't release a new drug without adequate testing. Considering the potential health (and economic) consequences of misunderstanding risks, we should be equally loath to release a new risk communication without knowing its impact."[23] It is intellectually inconsistent at best, and arrogant at worst, that scientists ignore or scoff at the need to understand people's perceptions. Why not do the same careful work on perceptions as they do on the risk assessment sciences with which they are more familiar? If they want to know whether a substance has a hormetic effect, they test that substance on animals. Risk communication should also be tested.

An empirical process by which to do this has been labeled the mental models approach. As its developers say "…in the absence of evidence, no one can predict confidently how to communicate about a risk. Effective and reliable risk communication requires empirical study. Risk messages must be understood by recipients, and their effectiveness must be understood by communicators."[a] The basic components of the mental models approach are:

1) Understand the mental model of the issue from the view of the experts in the field, based on review of the scientific literature and in consultation with those experts, which describes in detail the nature of the risk; its hazards, where exposures occur, the range of consequences, and the probabilities.
2) Understand the mental model of the issue held by your audience(s). Conduct open-ended interviews to find out what your target audience(s) already know or do not know about the risk.
3) Based on this first audience interview sample, create a questionnaire to administer to a larger sample to see how well the mental model of the

[a] *ibid*, p 182.

smaller group corresponds to what the larger sample knows and does not know about the risk.

4) Draft risk communication messages that address incorrect beliefs and fill in knowledge gaps between what people do not know and what the expert model indicates they need to know. Pay attention to the tone and affective qualities of the messages.
5) Evaluate and refine the communication using one-on-one interviews, focus groups, closed-form questionnaires, or problem-solving tasks, trying to develop messages that have the most impact on the greatest number of recipients. Repeat the test-and-refine process until evaluation shows the messages are understood as intended.

Conclusion

The Roman philosopher Epictetus said "Men are disturbed not by things, but by the view which they take of them." Fear is not just the product of fact-based rational analysis. It is a product of everything we can bring to bear on choices about survival… the facts, and our feelings.

Risk communication must respect this affect heuristic. It must validate it, not dismiss it as irrational. Risk communication will be less effective if it relies only on the facts to try and get people to think and do what the communicator would have them think and do. Risk communication will be more effective if it respects the fact that feelings guide our decision making, lay people and experts alike. Understanding the specific affective characteristics of non-linearity/hormesis is vital if those who support it want the public to consider the radical and potentially threatening idea that small doses of dangerous things might not be dangerous, or might even be beneficial.

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