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RISK PERCEPTIONS: "EXPERTS" vs. "LAY PEOPLE"

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I. RISK PERCEPTIONS

For some time now, discrepancies between expert assessments and lay perceptions of risk, sometimes called the "objective-perceived risk dichotomy," have concerned risk managers and theorists.[1] For example, in a 1987 study by the Environmental Protection Agency (EPA), experts ranked indoor radon and worker exposure to chemicals at the top of 31 environmental problems.[2] Roper polls of the lay public at around the same time produced much lower rankings for indoor air pollution, such as radon.[3] The Roper polls reveal that lay people rank chemical waste disposal and water pollution as posing the highest environmental risks.[4]

The first of ten recommendations made to EPA by the Science Advisory Board's "Reducing Risk" report was that "EPA should target its environmental protection efforts on the basis of opportunities for the greatest risk reduction."[5] EPA has interpreted this recommendation to mean that if radon is assessed as the greatest risk with the greatest risk reduction potential, it should be the primary focus of EPA efforts.[6] This would imply that radon should be prioritized over hazardous waste, and the government should spend as much or more money on radon risk communication and management as it spends on Superfund sites. This interpretation implies a conclusion that con-

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1. *See, e.g.,* U.S. EPA, UNFINISHED BUSINESS: A COMPARATIVE ASSESSMENT OF ENVIRONMENTAL PROBLEMS (1987); Paul Slovic et al., *Facts and Fears: Understanding Perceived Risk, in* SOCIETAL RISK ASSESSMENT: HOW SAFE IS SAFE ENOUGH? 181 (Richard C. Schwing & Walter A. Albers, Jr. eds., 1980); BRIAN WYNNE, RISK MANAGEMENT AND HAZARDOUS WASTE: IMPLEMENTATION AND THE DIALECTIC OF CREDIBILITY (1987); Paul B. Thompson, *Risk Objectivism and Risk Subjectivism: When Are Risks Real?*, 1 RISK- ISSUES IN HEALTH & SAFETY 3 (1990).

2. U.S. EPA, *supra* note 1, at 28.

3. *Id.* at 93.

4. *Id.* at 93.

5. SCIENCE ADVISORY BD., U.S. EPA, REDUCING RISK: SETTING PRIORITIES AND STRATEGIES FOR ENVIRONMENTAL PROTECTION 6 (1990).

6. *See id.*

tradicts public opinion, which illustrates how the definition of risk, like that of any other key term in public policy, is inherently controversial. Further, in what some regard as an expression of policy inconsistencies that can be attributed, at least in part, to public preferences, estimates of value-of-life statistics for risk management programs and control technologies show huge variability in societal investments.[7] Would society benefit from the resolution of such inconsistencies? More fundamentally, why are there discrepancies between expert assessments of risk and lay perceptions of risk?

"The choice of [a] definition [of risk] can affect the outcome of policy debates, the allocation of resources among safety measures, and the distribution of political power in society."[8] One formal definition of risk is "quantitative measures of hazard consequences expressed as conditional probabilities of experiencing harm," where hazards are threats to humans and things they value.[9] However, risk perceptions may not, and often do not, agree with this general, formal definition of risk.

Pidgeon defines risk perceptions as "people's beliefs, attitudes, judgments and feelings, as well as the wider social or cultural values and dispositions that people adopt, towards hazards and their benefits."[10] By this definition, risk perceptions appear to be inherently multidimensional and much more context sensitive than are formal measures of risk, which often include two dimensions - the probability and magnitude of harm - which are then combined and reduced to a single dimension (e.g., expected loss). Characterizing the differences between risk perceptions and formal measures of risk as a dichotomy between "perceived" versus "real" risk implies that the latter play a normative and prescriptive role, and that risk perceptions are somehow flawed or incomplete.[11] This debate lies at the heart of disagreements about risk management priorities. The aim of this paper is to first characterize expert assessments and definitions of risk

7. *See* Tammy Tengs et al., *Five-Hundred Life-Saving Interventions and Their Cost-Effectiveness*, 15 RISK ANALYSIS 369, 372 (1995).

8. Baruch Fischhoff, *Risk: A Guide to Controversy, in* IMPROVING RISK COMMUNICATION app. C at 258 (1989).

9. Christoph Hohenemser et al., *A Causal Taxonomy, in* PERILOUS PROGRESS: MANAGING THE HAZARDS OF TECHNOLOGY 67, 67-68 (Robert W. Kates et al. eds., 1985).

10. N. Pidgeon et al., *Risk Perception, in* RISK ANALYSIS, PERCEPTION AND MANAGEMENT: REPORT OF A ROYAL SOCIETY STUDY GROUP, LONDON 89 (1992).

11. *See, e.g.*, Kristin Shrader-Frechette, *Reductionist Approaches to Risk, in* ACCEPTABLE EVIDENCE: SCIENCE AND VALUES IN RISK MANAGEMENT 218 (Deborah G. Mayo & Rachelle D. Hollander eds., 1991); WYNNE, *supra* note 1; Thompson, *supra* note 1.

and then to provide an overview of findings from empirical research on lay risk perceptions. Finally, this paper takes a brief look at causal accounts of risk.

II. EXPERT RISK ASSESSMENTS

As stated above, formal definitions of risk generally encompass two dimensions: probability and magnitude of harm. However, formal definitions do not always agree. Even restricting risk to these two dimensions leaves the problem of how to combine the two undefined. Expert risk assessments will disagree if the experts do not agree on a combination rule as well as the probability and the magnitude of harm. A few definitions of risk illustrate how different combinations could produce different risk assessments:

- seriousness of (maximum) possible undesired consequences
- probability weighted sum of all possible undesired consequences (average 'expected loss')
- weighted combination of various parameters of the probability distribution of all possible consequences[12]

For example, defining harm as carcinogenicity and excluding reduction of ecological functionality in this definition of harm could lead to different risk management priorities than if both were included. Even if experts agree on the nature of the harms to be included and the probability distributions of those harms, experts who focus only on the worst outcome may reach different conclusions than those who calculate and use average expected loss.

Combination rules are only one of many sources of possible disagreements between experts. Other sources of disagreement arise where both probability and identification of harm require value judgments by experts in risk assessment. Wynne points out that many aspects of risk analysis involve informal judgments by experts. These judgments may confuse natural and behavioral influences on risks and underappreciate behavioral and social assumptions upon which they are based.[13]

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12. *See* Charles Vlek & Gideon Keren, *Behavioral Decision Theory and Environmental Risk Management: Assessment and Resolution of Four 'Survival' Dilemmas*, 80 ACTA PSYCHOLOGICA 249, 252 (1992).

13. *See* WYNNE, *supra* note 1, at 322-31; *see also* Shrader-Frechette, *supra* note 11.

Probabilities can be assessed using known relative frequencies which are then extrapolated to the specific context in question. This "frequentist" approach to probability estimation incorporates assumptions about the relevance of the available data to the particular context. It also incorporates assumptions about completeness and objectivity of the available data. For example, one's risk of dying in an automobile crash during Thanksgiving weekend may be assessed using data from the previous year. Such data are necessarily chosen from a limited time frame, collected with more or less adequate data collection techniques, and averaged over some set of circumstances (e.g., weather and traffic conditions, times of day, ages of drivers, etc.) that may be more or less relevant to one's own circumstances. Thus, data collection requires a series of judgments, some of which may be based on professional standards, while others may be the result of pragmatic considerations.

An alternative to the frequentist approach is a Bayesian or subjective approach, which is based on confidence. This approach acknowledges that prior information and beliefs, founded presumably on relevant expertise or experience may be relevant to the assessment of some probability and that experts will "update" their assessments as they incorporate new information.

Thompson discusses the contrast between objective, or frequentist, probability assessments and subjective probability assessments and concludes that neither is wholly satisfactory as a basis for risk judgments.[14] Thompson states: "The objectivist view makes it too hard for us to be right in making a risk judgment, while the subjectivist view makes it too hard for us to be wrong."[15] Thus, experts may disagree because they sometimes:

- rely inappropriately on limited data
- impose order on random events
- fit ambiguous evidence into predispositions
- omit components of risk, such as human errors or common-mode failures
- are overconfident in the reliability of analyses.[16]

14. *See* Thompson, *supra* note 1, at 21.
15. *Id.*
16. BARUCH FISCHHOFF ET AL., ACCEPTABLE RISK 18 (1981).

Other examples of what appear to be biased or limited definitions of risk include an emphasis on carcinogenicity over other physical effects, such as neurotoxicity or decreased fertility; a focus on mortality to the exclusion of morbidity; or a failure to recognize increased stress or other psychological or social effects. In addition, experts face the questions of whether, and if so how, to extrapolate from known risks (e.g., in the laboratory) to unknown risks (e.g., other circumstances or populations) and whether, and if so how, to reduce diverse risks to a single dimension (e.g., loss of utility).

Thus, technical risk assessments by experts can disagree dramatically.[17] Professional standards vary. Not only do standards for acceptable evidence differ for lawyers and scientists, but also for scientists in different fields.[18] For example, Barke and Jenkins-Smith have found that life scientists judge nuclear power and radioactive waste as riskier than their peers in other sciences judge them.[19] Scientists in universities tend to see these risks as greater than scientists who work as business consultants.[20] Barke and Jenkins-Smith also found that women and younger scientists are more risk averse than their peers, as demonstrated by their endorsements of more conservative dose-response models for policy purposes than for scientific purposes.[21] Such findings have led to the conclusion by some that science is socially constructed. Not only is it influenced by theoretical and methodological constraints in a given discipline or time period, but it is also influenced by the institutional and political interests of scientists and their organizations.[22]

Despite the numerous value judgments and biases that can influence expert risk assessments, such assessments are nevertheless based, ideally, on specialized information the average lay person is unlikely to know or have the resources to acquire. Knowledge about

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17. *See, e.g.*, Kenneth R. Hammond et al., *Improving Scientists' Judgments of Risk*, *in* JUDGMENT AND DECISION MAKING: AN INTERDISCIPLINARY READER 466, 466-79 (Hal R. Arkes & Kenneth R. Hammond eds., 1986); Kristin Shrader-Frechette, *Scientific Method, Anti-Foundationalism and Public Decisionmaking*, 1 RISK- ISSUES IN HEALTH & SAFETY 23, 28-32 (1990).

18. *See, e.g.*, Kenneth F. Schaffner, *Causing Harm: Epidemiological and Physiological Concepts of Causation*, *in* ACCEPTABLE EVIDENCE, *supra* note 11, at 204.

19. *See* Richard P. Barke & Hank C. Jenkins-Smith, *Politics and Scientific Expertise: Scientists, Risk Perception, and Nuclear Waste Policy*, 13 RISK ANALYSIS 425, 429 (1993).

20. *See id.*

21. Interview with Richard P. Barke, School of Public Policy, Georgia Institute of Technology, Atlanta, Ga. (Nov. 1996).

22. Branden B. Johnson, *Advancing Understanding of Knowledge's Role in Lay Risk Perception*, 4 RISK- ISSUES IN HEALTH & SAFETY 189 (1993).

relative frequencies, causal mechanisms, and information sources often enables experts to make predictions about risky processes that are much more reliable than uninformed judgments. Most of us would rather not try to do for ourselves the jobs we usually delegate to experts, such as nuclear engineers, doctors, auto mechanics - or even lawyers.

III. LAY RISK ASSESSMENTS

Tongue in cheek, Plough and Krimsiky depict lay concerns and priorities in risk assessment as "irrational." [23] They find that "[i]n [health risk assessment], the individual does not make rational choices about risky behaviors such as smoking and not wearing a seat belt and therefore the individual takes irresponsible risks. In [environmental risk assessment] the faulty logic is reversed: The individual maintains an "exaggerated" fear of hazards which experts consider to be relatively safe."[24] Health risk assessment and environmental risk assessment have the "irrational individual" in common.[25] Comparative risk assessment connects both of these constructions of the irrational individual.[26]

The basic problem of risk is that natural processes and human activities lead to interactions that create hazards. Risky processes consist of exposure, effects, perception, and valuation processes, which lead to outcomes producing both costs and benefits.[27] Risk management entails modifying one or more of these processes to adjust costs and benefits.[28] This may include modifying human activities, modifying exposure or effects processes, modifying perceptions and valuations, or mitigating or compensating.[29] Some would also argue that modifying natural processes can be part of the risk management process, as in the case of fertilizing the ocean with iron (as a possible way to reduce the risk of global warming).[30] Perceptions and

23. Alonzo Plough & Sheldon Krimsky, *The Emergence of Risk Communication Studies: Social and Political Context*, 12 SCI. TECH. & HUM. VALUES 4, 6 (1987).

24. *Id.*

25. *Id.*

26. *Id.*

27. *See* M. Granger Morgan, *Risk Analysis and Management*, 269 SCI. AM. 32, 33-40 (1993).

28. *See id.*

29. *See id.*

30. *See* F. Joos et al., *Estimates of the Effect of Southern Ocean Iron Fertilization on Atmospheric CO_2 Concentrations*, 349 NATURE 772 (1991).

valuations enter into all of these risk management intervention points, as well as into the latter part of the risky process itself.

An expert might argue that risk is only the severity of the event and the uncertainty associated with that event. Lay definitions tend to include both of these dimensions.[31] However, even if these were the only two dimensions included in lay perceptions, lay risk assessment would probably still differ from expert risk assessments due to a number of heuristics and biases that influence such quantitative estimates.

While subjective estimates of relative frequencies of harm are consistent across different response models, estimates of absolute frequencies are affected by the use of heuristics, such as anchoring, compression, and availability.[32] Anchoring is a tendency to focus or "anchor" on the first or most salient number given, and then to adjust inadequately from that number when making other estimates.[33] Anchoring shows a lack of feel for absolute frequency.[34] Compression is underestimating the spread or variability in a range of estimates.[35] Compression can lead to overestimates of small frequencies and underestimates of large frequencies.[36] Availability is the tendency to estimate the frequency of an event by the ease with which it is remembered.[37] Thus, events that are easily remembered or imagined, for example events in the news regularly, are more available and their frequencies overestimated.[38] People tend also to miscalibrate or become overconfident as a result of inadequate sensitivity to the limitations of their knowledge.[39]

Numerous other heuristics ("rules of thumb") and biases can influence risk judgments, including general context effects such as

31. *See* Wibecke Brun, *Risk Perception: Main Issues, Approaches and Findings, in* SUBJECTIVE PROBABILITY 295, 297 (George Wright & Peter Ayton eds., 1994).

32. *See* Baruch Fischhoff et al., *Risk Perception and Communication*, 14 ANN. REV. PUB. HEALTH 183, 186-87 (1993).

33. *See id.* at 187; *see generally* Amos Tversky & Daniel Kahneman, *Judgment Under Uncertainty: Heuristics and Biases, in* JUDGMENT AND DECISION MAKING, *supra* note 17, at 49-53.

34. *See* Fischhoff et al., *supra* note 32, at 187.

35. *See id.*

36. *See id.*

37. *See* Tversky & Kahneman, *supra* note 33, at 46-49.

38. *See id.*; *see also* Colin MacLeod & Lynlee Campbell, *Memory Accessibility and Probability Judgments: An Experimental Evaluation of the Availability Heuristic*, 63 J. PERSONALITY & SOC. PSYCHOL. 890, 894-897 (1992).

39. *See* Fischhoff et al., *supra* note 32, at 187-88; *see also* Jack B. Soll, *Determinants of Overconfidence and Miscalibration: The Roles of Random Errors and Ecological Structure*, 65 ORGANIZATIONAL BEH. & HUM. DECISION PROCESSES 117 (1996).

framing and biases toward optimism and risk aversion.[40] Framing effects, for example when the same risk is described or framed in terms of losses instead of gains, can lead to preference reversals.[41] People also make errors in combining information, in part due to anchoring, but also because specifics may seem more likely than generalities. To illustrate the former, lay people do not appear to accumulate estimates of single exposures at a high enough rate.[42] To illustrate the latter, a combination of circumstances that make a good story may seem more likely than the general case - an example of the "conjunction fallacy."[43] Optimism has been found in numerous judgments of risks because people tend to see themselves at less risk when compared to others.[44] In a final example, people tend to prefer zero risk - they prefer total elimination of a small risk over a large reduction in another risk.[45] Many of these findings come out of research in behavioral decision theory and have been influenced heavily by prospect theory and its successor, cumulative prospect theory.[46]

A study by von Winterfeldt et al. interprets a test of the accuracy of perceptions of fatality risks as evidence that "fatality probability operates as a primary determinant for intuitive risk judgments," and that under some circumstances experts and laypersons may both form judgments of risks on the basis of fatality rates.[47] However, the study

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40. *See* JONATHAN BARON, THINKING AND DECIDING 224-238 (1994); SCOTT PLOUS, THE PSYCHOLOGY OF JUDGMENT AND DECISION MAKING 107-88 (2d ed. 1993).

41. *See* X.T. Wang, *Framing Effects: Dynamics and Task Domains*, 68 ORGANIZATIONAL BEH. & HUM. DECISION PROCESSES 145 (1996).

42. *See* Patricia W. Linville et al., *AIDS Risk Perceptions and Decision Biases, in* THE SOCIAL PSYCHOLOGY OF HIV INFECTION 5, 15-16 (John B. Pryor & Glenn D. Reeder eds., 1993).

43. *See generally*, Amos Tversky & Daniel Kahneman, *Extensional Versus Intuitive Reasoning: The Conjunction Fallacy in Probability Judgment*, 90 PSYCHOL. REV. 293 (1983).

44. *See* Ola Svenson, *Are We All Less Risky and More Skillful Than Our Fellow Drivers?*, 47 ACTA PSYCHOLOGICA 143, 146 (1981); *see also* Neil D. Weinstein & William M. Klein, *Unrealistic Optimism: Present and Future*, 15 J. SOC. & CLINICAL PSYCHOL. 1, 1-2 (1996).

45. *See* Ilana Ritov et al., *Framing Effects in the Evaluation of Multiple Risk Reduction*, 6 J. RISK & UNCERTAINTY 145, 157 (1993).

46. Prospect theory is an alternative to expected utility theory that replaces "utility" (defined in terms of net wealth) with "value" (defined in terms of gains or losses from a reference point). The value function for losses is convex and steeper than that for gains, which is concave. *See* Daniel Kahneman & Amos Tversky, *Prospect Theory: An Analysis of Decision Under Risk*, 47 ECONOMETRICA 263 (1979); *see also* Hein Fennema & Peter Wakker, *Original and Cumulative Prospect Theory: A Discussion of Empirical Differences*, 10 J. BEHAVIORAL DECISION MAKING 53 (1997); Amos Tversky & Daniel Kahneman, *Advances in Prospect Theory: Cumulative Representation of Uncertainty*, 5 J. RISK & UNCERTAINTY 297 (1992).

47. Detlof von Winterfeldt et al., *Cognitive Components of Risk Ratings*, 1 RISK ANALYSIS 277, 286-87 (1981).

also acknowledges that catastrophic potential influences risk judgments of lay persons.[48]

What people perceive as an undesirable effect depends on their values and preferences.[49] When a formal definition of risk is used, as experts often use, people may disagree with it because the numerical combinations of magnitude and probabilities tend to assume equal weight for both.[50] However, there is much evidence that lay definitions of risk depend on more than just the severity of the event and the uncertainty associated with that event.[51] Interactions between human activities and consequences are more complex and unique than the interactions accounted for by the average probabilities used in technical risk analyses.[52]

Some researchers have divided perceived risk into two parts: hazard dimensions and outrage factors—the sum of which equals perceived risk.[53] Hazard dimensions consist of the two dimensions, probability and magnitude of harm, discussed previously in the context of formal expert risk assessments. Outrage factors include the kinds of attributes captured in psychometric research by variables such as catastrophic potential or "familiarity." Researchers conclude that risk perceptions are supported by sets of consistent beliefs, not just irrational fears and unbridled emotions.[54]

It follows that lay people can assess annual fatalities, at least ordinally, but their judgments of risk correlate with other characteristics of hazards as well, including catastrophic potential and controllability. Psychometric research by Fischhoff, et al. concludes that two or three dimensions of risk are important predictors of whether peo-

48. *See id.* at 287.

49. For example, some people may find white lies acceptable, while others find them completely unacceptable and find social situations that require them awkward.

50. *See* Ortwin Renn, *Concepts of Risk: A Classification, in* SOCIAL THEORIES OF RISK 53, 59 (Sheldon Krimsky & Dominic Golding eds., 1992).

51. *See, e.g.,* Baruch Fischhoff et al., *How Safe is Safe Enough? A Psychometric Study of Attitudes Towards Technological Risks and Benfits*, 9 POL'Y SCI. 127 (1978); Paul Slovic et al., *Characterizing Perceived Risks, in* PERILOUS PROGRESS, *supra* note 9, at 91; Paul Slovic, *Perceptions of Risk: Reflections on the Psychometric Paradigm, in* SOCIAL THEORIES OF RISK, *supra* note 50, at 117.

52. *See* Renn, *supra* note 50, at 59.

53. *See* PETER M. SANDMAN ET AL., N.J. DEP'T OF ENVTL. PROTECTION AND ENERGY, IMPROVING DIALOGUE WITH COMMUNITIES: A RISK COMMUNICATION MANUAL FOR GOVERNMENT 8 (1988). *See also* Abraham H. Wandersman & William K. Hallman, *Are People Acting Irrationally? Understanding Public Concerns About Environmental Threats*, 48 AM. PSYCHOLOGIST 681, 683 (1993).

54. *See* Renn, *supra* note 50.

ple perceive a risk.[55] The two primary factors are familiarity, which is assessed using questions about how voluntary, well-known, and controllable the risk is, and dread, which is assessed using questions about whether the risk poses a high catastrophic potential or a threat to future generations.[56] The third dimension is a measure related to exposure, such as how many people are exposed. The studies from which these conclusions are drawn involve asking people large sets of questions about risks and using statistical analysis to reduce the data to a few dimensions that capture most of the variability in the answers.[57] For example, judgments of voluntariness, how well-known and how controllable a risk is, tend to be correlated, for which reason they are designated by the researchers as a single dimension of risk - familiarity.[58]

In addition to these general influences on risk perceptions, individual differences among lay people must also be born in mind. These differences can be due to geographical location and proximity to risk, susceptibility to specific effects due to age or infirmity, occupation, inequities in exposure, or access to risk control. Discrepancies in knowledge about specific risks, such as radon, may also influence various communities' ability to control risk. A national survey on radon completed by the Conference on Radiation Control Program Directors in collaboration with EPA included questions designed to assess people's awareness of and knowledge about radon.[59] The results show that awareness of radon is much lower among minority groups, such as blacks and Hispanics, than among whites. In Georgia, 39% of the population had not heard of radon.[60] By race, 31% of whites had not heard of radon, while 60% of non-whites had

55. *See* Fischhoff et al., *supra* note 51.

56. *See id.*

57. *See id.*

58. Some suggest that psychometric risk perceptions should be combined with expert risk assessments to determine risk acceptability, as in comparative risk exercises. *See* M. Granger Morgan, *A Proposal for Ranking Risk Within Federal Agencies, in* COMPARING ENVIRONMENTAL RISKS TOOLS FOR SETTING GOVERNMENTAL PRIORITIES, 111 (J. Clarence Davies ed., 1996). Wynne suggests that psychometric risk perception research, as illustrated, for example, by Slovic, is incomplete and can mislead the unwary consumer to confuse social and institutional dimensions of risk with psychological or cognitive dimensions. *See* WYNNE, *supra* note 1; Paul Slovic, *Perception of Risk: Reflections on the Psychometric Paradigm, in* SOCIAL THEORIES OF RISK , *supra* note 50.

59. CONFERENCE ON RADIATION CONTROL PROGRAM DIRS., U.S. ENVTL. PROTECTION AGENCY, RADON BULLETIN, Spring 3 (1993).

60. *See id.* at 1.

not heard of radon.[61] By income, 57% of those with a self-reported household income under $25,000 had not heard of radon, compared to 33% of those with higher incomes.[62] As with experts, there is not a single, homogenous lay public in risky matters.

IV. CAUSAL ACCOUNTS: MODELS OF HAZARDOUS PROCESSES

While the discussion above has touched briefly on notions related to causal processes, the focus has been on judgments of probability and harm. Thompson distinguishes between judgments of probability and harm and causal accounts: "The general answer to the question, 'When are risks real?' is that risks are real when there is sufficient reason to suspect the presence of a causal sequence that would produce the unwanted event."[63]

As alluded to earlier, defining what the hazardous process includes — in other words determining a causal account — is key to defining risk and is a role experts often take in our society. Experts' mental models of hazardous processes result from long hours of study and much experience. Consequently, these models differ fundamentally from lay mental models.[64] By comparison, studies of lay mental models of hazardous processes have found that:

> Lay thinking about complex risks can be sophisticated, but tends to be simpler and more general than experts', and is more susceptible to errors. For example, people often confuse global warming with stratospheric climate change (at a mechanistic level) and some may attribute global warming to "pollution" generally.[65]

Lay misconceptions about risks include erroneous beliefs that are more commonly related to missing details or a misunderstanding of the relative importance of subprocesses in a hazardous process (i.e., a misplaced focus on peripheral influences). So, for example, some people may believe that exposures to radon are due primarily to industrial or mining wastes, such as uranium mill tailings, when, in

61. *See id.*

62. *See id.*

63. *See* Thompson, *supra* note 1.

64. *See generally* Michelene T.H. Chi et al., *Categorization and Representation of Physics Problems by Experts and Novices*, 5 COGNITIVE SCI. 121 (1981). *See also* Ann Bostrom et al., *Characterizing Mental Models of Hazardous Processes: A Methodology and an Application to Radon*, 48 J. SOC. ISSUES 85 (1992).

65. *See* Ann Bostrom et al., *What do People Know About Global Climate Change? 1 Mental Models* 14 RISK ANALYSIS 959 (1994).

reality, indoor radon from soil gas is the primary source of exposures for most people.[66]

Risk control decisions and attitudes can be affected by misconceptions. This sometimes leads to support for ineffective risk control measures.[67] One example is an apparently common misconception that eliminating spray cans will substantially reduce the risk of global warming.[68] Spray cans may be viewed as less risky if people are informed and are willing to accept that spray cans are not the primary culprits behind global warming.

Addressing misconceptions and knowledge gaps with incomplete information may increase anxiety. If one does not provide people with information that both completes and corrects their mental models, one may cause undue worry by amplifying the perceptions of risk severity without providing information on how the risk can effectively be controlled.[69]

It is not always easy to distinguish between misconceptions and disagreements. One example of this is from research on perceptions of power frequency fields. People sometimes believe that they can detect or perceive power frequency fields and will discuss such perceptions in everyday contexts, such as walking beneath a power line.[70] While very strong fields can be detected with physical sensations, exposure to such fields in daily life is extremely unlikely. In this case, what could be construed as a disagreement about relevant circumstances is probably a misconception.

As Thompson points out, causal accounts do not allow one to distinguish between the relative seriousness of equally real risks.[71] In this context, seriousness could be construed as likelihood, severity, or some combination of the two. Thus, in a comparative risk context,

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66. *See id*.

67. *See id.*

68. *See id.*

69. Models such as Witte's postulate that knowing how serious a risk is (severity or threat) and efficacy - knowing what to do about something - are essential components of health risk communication. One without the other could lead to undue worry or complacency, respectively. *See* Kim Witte, *Fishing for Success: Using the Persuasive Health Message Framework to Generate Effective Campaign Messages, in* DESIGNING HEALTH MESSAGES: APPROACHES FROM COMMUNICATION THEORY AND PUBLIC HEALTH PRACTICE 145 -51 (Edward Maibach & Roxanne Louiselle Parrott eds., 1995); see also Baruch Fischhoff, *Treating the Public with Risk Communication: A Public-Health Perspective*, 12(3&4) SCI., TECH. & HUM. VALUES 13-14 (1987).

70. *See* M. Granger Morgan et al., *Lay Understanding of Power-Frequency Fields*, 11 BIOELECTROMAGNETICS 313, 316, 321 (1985).

71. *See* Thompson, *supra* note 1.

causal accounts are necessary but insufficient for the formulation of public policy.

IV. CONCLUSIONS

Lay people and experts alike use what they know to interpret new information and make judgments about risks. Their mental models of risks and prior beliefs about the risk communication source are likely to affect how they interpret risk communication. In subjective assessments, people also may use heuristics, which can lead to biases. For example, cumulative probabilities may make an event seem riskier than the equivalent 'one shot' probability; framing can affect judgments and decisions. However, people also care about processes as well as outcomes. For example, people may view imposed risks differently from voluntary risks, catastrophic risks differently from those without a catastrophic potential. While such differences as these have been explored most in psychometric studies, alongside recent discussions of trust they illustrate the importance of social and institutional contexts of risk. Comparisons of expert risk assessments with lay risk perceptions can all too easily focus on differences in knowledge and expertise, while ignoring equally real differences in individual contexts, motives, and even values.