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Testing the Role of Technical Information in Public Risk Perception*

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Introduction

Experts and laypersons have long disagreed about which risks to human health and safety and the environment should be of greatest concern. Experts in environmental health are most concerned about public overestimation of low-probability risks, although alleged underestimation of high-probability risks, e.g., radon, also concerns them. They assume that risk overestimation is the basis of citizen disagreement with experts, and that overestimation is due to ignorance of technical facts.[1] The solution to the conflict, then, is to reduce public ignorance through education about the toxicity, exposure routes and health effects of environmental toxicants.

These are, however, assumptions. It is not clear that knowledge or ignorance of technical facts drives risk estimation, or that risk estimation

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1 Paul Slovic, Baruch Fischhoff & Sarah Lichtenstein, *Rating the Risks*, 21 ENVIRONMENT 3, 14-20, and 36-39 (1979); U.S. ENVIRONMENTAL PROTECTION AGENCY, UNFINISHED BUSINESS: A COMPARATIVE ASSESSMENT OF ENVIRONMENTAL PROBLEMS (1987).

is the central factor in public risk perception.[2] It is even less clear whether providing citizens with technical risk information will alter their perceptions of risk or their views of how well government agencies are protecting the environment. Several studies suggest that agency behavior — for example, in coping with the effects of Chernobyl[3] or in planning for a nuclear waste repository at Yucca Mountain[4] — has far more impact on public views than agencies' technical information.

The study on which this paper is based[5] compared the effects of three variables in hypothetical newspaper stories: (1) the amount of technical information provided, (2) the extent to which government officials were responsive or unresponsive and citizens were calm or upset,[6] and (3) the magnitude of the risk, e.g., concentration of a hazardous chemical in water or number of households exposed. This paper reviews methodological and conceptual challenges of testing the effect of technical information, reports results of one test of technical detail on perceived risk and perceived appropriateness of government action, and suggests approaches for future research.

Possible Roles of Technical Information

Study of the effect of technical information on risk perception faces several challenges. One must determine what effects should be expected and what kind of information is pertinent. Scientists advocating more communication of technical information to the public presume that

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2 THE SOCIAL AND CULTURAL CONSTRUCTION OF RISK: ESSAYS IN RISK SELECTION AND PERCEPTION. (Branden B. Johnson & Vincent T. Covello, eds. 1987).

3 Brian Wynne, *Sheepfarming After Chernobyl: A Case Study in Communicating Scientific Information,* Environment, March 1989, at 10-15, 33-40.

4 Paul Slovic, Mark Layman & James H. Flynn, *Risk Perception, Trust, and Nuclear Waste--Lessons from Yucca Mountain,* Environment, April 1991, at 6.

5 Peter M. Sandman & Paul Miller, Outrage and Technical Detail: The Impact of Agency Behavior on Community Risk Perception (Final Report to NJDEPE DSR 1991). Available from ECRP or NJDEPE-DSR.

6 Referred to here as the "outrage" variable. For a more complete report on outrage effects, *see* Peter M. Sandman, Paul Miller, Branden B. Johnson & Neil D. Weinstein, *Agency Communication, Community Outrage, and Perception of Risk: Three Simulation Experiments,* Ms., 1991.

information will lead citizens to see the risks the same way experts do, e.g., view low-probability risks as insignificant. Scholars who document the public's lack of knowledge about science also imply that improving scientific literacy will reduce disagreements between experts and citizens.[7]

Some scholars propose that people update their knowledge in a Bayesian fashion from hazard-related information. Thus, perceived seriousness of a risk in a followup survey is believed to be a weighted average of earlier perceptions of risk seriousness and the message people see in information they have received in the interim. One study found, for example, that quantitative information about radon is superior to qualitative information in reducing gaps between objective and subjective risks.[8] Yet, information-updating studies have not examined the effects of different topics of technical information, nor can Bayesian theorems predict such effects. In other words, these studies tell us that providing information may make a difference but do not suggest what information makes the difference.

Allan Mazur has argued that the more people see or hear about the risks of a technology, e.g., as measured in overall media coverage of the topic, the more concerned they will become. This effect, he suggested, would occur whether the coverage was positive or negative; the mere mention of risks, well- or poorly-managed, was enough to make the risks more memorable and thus increase public estimates of risk.[9] The same effect might occur when technical information appears in a single news story, if readers construed the inclusion of such information as a signal that the issue deserves considerable attention and concern. This signal would be all the stronger because technical information is not a common attribute of news stories.[10]

7 Jon D. Miller, *Scientific Literacy: A Conceptual and Empirical Review*, Daedalus, Spring 1983, at 29.

8 F. Reed Johnson & Ann Fisher, *Conventional Wisdom on Risk Communication and Evidence from a Field Experiment*, 9 RISK ANAL. 209 (1989).

9 Allan Mazur, *Media Coverage and Public Opinion on Scientific Controversies*, 31 J. COMM. 106 (1981); Allan Mazur, *Nuclear Power, Chemical Hazards, and the Quantity of Reporting*, Minerva, Autumn 1990, at 294.

Alternatively, inclusion of technical jargon could be interpreted as an attempt to hide something, justifying and provoking extra concern. Some studies contradicted Mazur's thesis for effects of overall media coverage;[11] other hypotheses have not been tested. All of them, if true, imply that sharing technical risk information with the public would increase perceived risk, the opposite effect from that proposed by many risk professionals.

Yet another possibility is that technical content might interact with other attributes of the news story to affect risk perceptions. For example, technical detail might make a story more credible, hence a frightening story scarier and a calming story more reassuring. One test of this hypothesis found no such interaction, and no direct effect of technical detail on readers' alarm or comfort.[12] What effects technical information might have combined with such story attributes as topic or media outlet have yet to be formulated, much less tested.

Clearly there are several, potentially contradictory, plausible effects of technical information on risk perception. In addition, there are several possible kinds of technical information that might exert these effects. Officials and experts who call for public education rarely specify which kind of data they expect to work and may not know themselves how to proceed. However, it is difficult to imagine circumstances under which officials would fail to tell the public about potential exposure routes and health effects of chemicals involved in an environmental spill, for example. So, the pertinent comparison is not between zero and some, but between some and more (or different), information.

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[10] MASS MEDIA AND THE ENVIRONMENT (David M. Rubin & David P. Sachs, eds. 1973); PETER M. SANDMAN ET AL., ENVIRONMENTAL RISK AND THE PRESS (1987).

[11] David L. Protess et al., *The Impact of Investigative Reporting on Public Opinion and Policymaking: Targeting Toxic Waste*, 51 PUB. OPINION Q. 166 (1987); Roger E. Kasperson et al., *Social Amplification of Risk: The Media and Public Response*, in HIGH-LEVEL WASTE AND GENERAL INTEREST 131-135 (Vol. 1: WASTE MANAGEMENT '89: WASTE PROCESSING, TRANSPORTATION, STORAGE AND DISPOSAL, TECHNICAL PROGRAMS AND PUBLIC EDUCATION, R.G. Post, ed. 1989).

[12] KANDICE L. SALOMONE, NEWS CONTENT AND PUBLIC PERCEPTIONS OF ENVIRONMENTAL RISK: DOES TECHNICAL RISK INFORMATION MATTER AFTER ALL? (Rutgers University, *in press* 1992).

Several potential comparative issues about what information to include confront the designer of research on the effects of technical information:

1. *Detail vs. length of discussion.* Compare a statement that short-term exposure to high levels of a chemical "can cause a wide range of health effects" to one that it "can cause a wide range of health effects, such as loss of muscle coordination, weakness, restlessness, and irritation of the eyes and skin." Would differing effects of these statements, if any, be due to greater detail or greater length of the second? This confusion is exacerbated if the manipulation of technical detail includes sub-details (e.g., exposure routes as well as health effects). Each contrast across the stories potentially widens the gap in story length. We would need to compare a story with technical detail to another story of equal length but without technical detail.

2. *Detail varying in kind vs. amount.* One story may detail health effects, while another discusses dose-response relationships. Are any observed differences in dependent variables due to amount of detail or to story length or to kind of information?

3. *Neutral vs. alarming or reassuring information.* For example, would otherwise identical accounts of health effects, with one including cancer, foster identical risk perceptions?

4. *Technical information's effects on perceived risk vs. audience size.* A science- and jargon-filled story may cause readers or viewers to stop paying attention, or it may alarm or reassure them.

5. *Technical information vs. scientific certainty.* Experts often argue that laypeople are too prone to seek certainty, while greater knowledge leads to understanding that certainty does not exist. In this view the value of providing more detail is that it grounds generalizations in data, theory, and caveats. Detail makes otherwise misleadingly simple statements more accurate and credible. In this view the second of the following two versions of health effects data will increase uncertainty about health effects:

> Scientific research has linked long-term PERC exposure to some kinds of cancer in test animals.
>
> Scientific research has linked long-term PERC exposure

> to liver cancer in mice and leukemia in rats. Although no evidence has been found concerning cancer in humans, EPA considers PERC a "suspected human carcinogen."

However, these presumed effects of information about uncertainty may not occur. Citizens who fail to find certainty, whether or not they are told directly that it does not exist, may become alarmed despite otherwise believing a technical statement. If many laypeople believe science should produce certainty,[13] uncertainty in technical information could even reduce credibility, and thereby raise perceived risk. Thus the effects of more information must be carefully separated from the effects of uncertainty engendered by the information.

6. *Potentially intervening variables.* For example, the trustworthiness of the person or organization supplying technical information may affect its impact. Several studies[14] have found that the public sees wide differences in the credibility of various institutions on environmental issues. Environmentalists are usually most credible, industry least credible, and government moderately credible. Credibility also could be affected by whether the source communicates as expected. For example, New Jersey citizens said they would find state officials more credible if they declared an environmental problem to be dangerous than if they said it was not,[15] and the same is probably true of industry. In contrast, environmentalists should be most trusted when they say something is safe. Technical information challenged by (trusted) opponents should be less credible than information left unchallenged, or even supported, by opponents.

7. *Channel that conveys technical information.* Suppose that news stories with details about exposure pathways and health effects do not affect risk perceptions. We cannot conclude that the same information would be ineffective if conveyed through other channels. Technical

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[13] Dorothy Nelkin, *Creation versus Evolution: The California Controversy*, in CONTROVERSY: POLITICS OF TECHNICAL DECISIONS, 213, at 224-25 (Dorothy Nelkin, ed. 1979).

[14] *See* review in Branden B. Johnson, *Public Perceptions and the Public Role in Nuclear and Chemical Waste Facility Siting*, 11 ENVT'L MGMT. 571 (1987).

[15] Neil D. Weinstein, Public Perception of Environmental Hazards: Statewide Poll of Environmental Perceptions (Final Report, N. J. Dept. Envt'l Prot'n, DSR 1987).

information may have a stronger effect in more direct and personal interactions, such as public meetings or one-on-one conversations. These situations allow for questions and answers to clarify the data, time to add metaphors and other comparisons, and the building of a potentially trusting relationship. Even other printed material may be more effective than press stories, whose users include many people not actively looking for risk information, or indeed looking for anything other than entertainment. Fact sheets and brochures passed out to interested parties may be processed more easily than media accounts; they focus on a single topic, and readers are more highly motivated. In contrast, detail communicated through the mass media may only reduce story readability, introducing, e.g., the concept of probability, without enough information to make sense of this new idea. These differences may affect risk perceptions.

8. *Clarity with which technical detail is conveyed.*[16] Clarity encompasses many attributes, such as jargon, sentence length, sentence complexity, tone, organization of ideas and active vs. passive voice. This, too, could affect risk perceptions.

Assessing the effect of technical information on risk perceptions involves a number of challenging issues. The pilot study described below involved a government source using a mass media channel to convey information, varying in detail and (slightly) in length but not in kind, about a spill of a potentially carcinogenic chemical. Researchers varied the magnitude of the risk and statements of the government spokesman about agency action. This provided a test of the hypothesis that different messages about risk from a given source can elicit different reactions. The study was a first step toward clarifying the direct and interactive effects of variables discussed above, with a focus on two:

- Do laypeople recognize more detailed technical information (as defined by experts) as more detailed?
- Does reading more detailed technical information about an environmental problem affect lay views of the risks or of the government information source managing the risks?

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16 G. Ray Funkhouser & Nathan Maccoby, *Communicating Specialized Science Information to a Lay Audience*, 21 J. COMM. 58 (1971).

Research Design

Hypothetical news stories about a spill of perchloroethylene (PERC) were developed, each with a "low" or "high" value for each of three treatment variables: outrage, risk magnitude and technical detail. Appendix I contains examples of these stories. The channel used was a newspaper story because such stories are widely used to disseminate environmental information. Also, environmental professionals see newspaper stories as potentially very distorting of lay risk perceptions, but dominant and unavoidable because most Americans get most of their information through television broadcasts or newspapers.[17]

The source of technical information in these stories was the New Jersey Department of Environmental Protection and Energy (NJDEPE), which sponsored the study.[18] Government agencies also are the single largest source of media stories on the environment.[19]

The "outrage" factor varied the agency spokesperson's behavior. He did or did not willingly share information, promise review of regulations, and arrange for wellwater and exposure testing. The story also varied reported levels of residents' distress. The stories thus included two kinds of reported behavior: that of the agency spokesperson and of residents. Such "person on the street" reactions to government statements are typical of news stories on environmental issues. These two sets of behaviors may have joint, separate, or offsetting effects on risk perception, just as may two government actions, e.g., to share information and review regulations. However, one must first see if outrage in general affects risk perception before analyzing the effects of subvariables. To keep story length workable, critiques of technical information by other groups were not included.

The "magnitude" variable altered the estimated toxicity of PERC, the estimated exposures resulting from the spill, and the number of people

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17 Judy Shaw & Branden B. Johnson, A Look Inside: Risk Communication and Public Participation within the New Jersey Department of Environmental Protection (N. J. Dept. Envt'l Prot'n, DSR 1990).

18 The stories in Appendix I use the name of the agency at the time of the study: the New Jersey Department of Environmental Protection.

19 Rubin & Sachs and Sandman et al., both *supra* note 10.

exposed. Risk magnitude varied overall between the two versions by nearly five orders of magnitude (approximately 80,000 fold).

Technical information was more or less detailed in its presentation of facts about exposure pathways, health effects, and evidence for those health effects. The cancer health effects example provided above[20] was included in both pilot and field tests. The example for non-cancer effects[21] was included only in the pilot tests. Varying the amount of detail given for the same technical topics avoided confusing these effects with those from differing kinds of information. Technical details were reviewed for accuracy by NJDEPE scientific staff. The amount of detail in the two versions was a plausible reflection of detail likely in actual news stories. The study only partly controlled for the possible effect of story length. High-detail stories were about 14% longer (105 vs. 92 lines) than low-detail stories. However, both filled nearly two columns[22] and readers may not see them as differing much.[23]

The issue of whether detail raised or lowered perceived uncertainty was not addressed. Due to limited resources, all three of the manipulations (detail, outrage, risk magnitude) included several sub-variables, including potential uncertainty (about whether PERC caused cancer in humans) in the technical detail variable. This meant the study also could not separate the effects of uncertainty from the effects of other sorts of technical detail.

Table 1 details the variables measured in this design in the field study. The instrument (Appendix II) included statements intended to measure risk aversion. Previous research[24] suggested that controlling for this variable might provide a more powerful test of risk perception hypotheses.

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20 *See* issue no. 5, concerning what technical information to provide.

21 *See* issue no. 1 above.

22 *See* Appendix I.

23 This perception was not measured by the survey instrument.

24 Weinstein, *supra* note 15.

Table 1
Variables Used in Study

Experimental Independent Variables	
OUTRAGE	Agency behavior and local response, described in story. Categorical variable: 1 = high, 2 = low.
TECHNICAL DETAIL	Detail on health effects and exposure in story. Categorical variable: 1 = high, 2 = low.
MAGNITUDE	Size of risk described in story. Categorical variable: 1 = high, 2 = low.
Response Variables	
SERIOUS RISK	Question 1.[25] Rating from 1 = not at all serious, to 6 = extremely serious. Originally conceived as a manipulation check on MAGNITUDE.
PERCEIVED APPROPRIATENESS	Question 2. Rating from 1 = not at all appropriate, to 6 = extremely appropriate. Originally conceived as a manipulation check on OUTRAGE.
PERCEIVED DETAIL	Question 3. Rating from 1 = not at all detailed, to 6 = extremely detailed. Originally conceived as a manipulation check on TECHNICAL DETAIL.
WORRY	Question 4. Rating from 1 = not at all worried, to 6 = extremely worried.
INTENTION TO TEST	Question 5. Rating from 1 = not at all willing, to 6 = extremely willing.
IMPORTANT RISK	Question 6. Rating from 1 = not at all important, to 6 = extremely important.
PERCEIVED RISK	Composite index of SERIOUS RISK, WORRY, and IMPORTANT RISK. Range from 3 = low risk, to 18 = high risk.
Risk Aversion Variables	
SOCIETAL RISK AVERSION	Sum of aversion questions 1 and 4. Rating from 2 = very strongly disagree with both, to 14 = very strongly agree with both.
PERSONAL RISK AVERSION	Sum of aversion questions 2 and 3. Same rating.
Demographic Variables	
SEX	Categorical variable: 1 = male; 2 = female.
AGE	Grouped in five-year intervals, from 1 = 18–22, to 10 = over 62.
EDUCATION	From 1 = some grade school, to 9 = graduate degree.

[25] References to questions refer to items in Appendix II, Research Questionnaire.

Pilot Studies

Before testing the effect of technical detail on perceived risk, one must determine whether laypeople recognize technical detail as defined by experts; i.e., are lone paragraphs that contain more detail according to experts seen by lay readers as more detailed? When these paragraphs are combined in entire stories about the PERC spill, do readers distinguish the stories' respective levels of detail? These issues are important because they affect the value of providing technical information to citizens. If the public cannot recognize expert-defined detail as indeed more detailed, whether in separate sentences, paragraphs or entire stories, presenting the data as being more detailed may backfire if citizens want details. They will believe their demand evoked no response and may react with anger. Alternatively, if readers do not notice greater detail, more information could be put into a story without people feeling that they are asked to do a lot of mental work.

Eighty-six Rutgers University undergraduates read one of two versions (high or low on all three manipulation variables) of the one-page simulated news story. Then, without being allowed to refer to the story, they answered written questions about their overall reactions to the news stories. Finally, they rated the technical detail in three highlighted passages in a second copy of the mock news story.

In their reading of the entire story, subjects reading more and less detailed stories expressed no difference in amount of perceived detail in the story, clarity of information about the risk, or their resulting understanding of the nature and extent of the risk. There was no significant correlation between perceived risk and either actual or perceived level of detail.

When their attention focused on specific paragraphs, however, subjects who read more detailed paragraphs saw more detail about potential health effects and rated their understanding of health effects as higher. No significant differences were found for the equivalent measures about exposure routes. This part of the pilot study thus found that at least sometimes experts and laypeople can agree on which paragraphs are more detailed. The amount of detail in specific paragraphs was not significantly correlated with perceptions of the spill's risk or seriousness, its likelihood to cause a health problem in the family, the anger it caused, or the importance of NJDEPE taking remedial action.

The level of variability in the measures and centrality of responses ruled out instrument biases as an explanation of these results. Moreover, NJDEPE experts judged that there was a substantial difference in the amount of technical detail contained in the news stories. In fact, the highly detailed version was judged to exceed the amount of detail in typical journalistic coverage of environmental spills. Thus this difference in perceived detail for the whole news story between citizens and experts seems to be a substantive finding rather than a methodological shortcoming.

A second pretest with 42 Idaho State University students was identical to the first, except it deleted the paragraph-rating task and added six items testing societal and personal risk aversion. Again the technical detail manipulation did not work; subjects' ratings did not distinguish between the two stories in terms of the overall amount of detail. Controlling for risk aversion did increase the sensitivity of the tests of differences due to detail on some of the dependent variables. Significance increased from 0.05 to 0.01 for the affective measure of anger, and the cognitive measure of the risk's "importance" went from non-significant to significant at 0.05. However, the correlations of technical detail with all measures of perceived risk remained non-significant even controlling for risk aversion.

The pilot studies suggested that merely providing more technical information does not make people see a news story as more detailed, nor alter their risk perceptions. However, given the small and collegiate character of these samples, these findings still needed to be tested in a larger field study. It could not be assumed that mature homeowners would react the same as college students. Far more important, even if citizens do not perceive technical detail as do experts, experimental manipulation of technical detail may still affect perceived risk. Greater detail could shift risk perceptions without readers being aware that there was more detail in the story they read. Three variables were thus of interest for the field study: (1) technical detail as defined and varied by the researchers and NJDEPE, (2) detail as perceived by the subjects, (3) and perceived risk (and its behavioral correlate, intention to test one's well water).

Field Study

For the field test, we shortened the simulated news stories, and revised elements that seemed to confuse pretest subjects. The agency advisory committee also wanted additional changes in the stories to make them more technically accurate and realistically depict agency behavior. The survey instrument also was shortened to include several questions allowing responses on a Likert scale (Table 1 above).

Time and budget constraints altered the original plan for a 2x2x2 design to vary each of the three treatment variables. Instead, five stories were used. Both outrage and technical detail were varied in high and low versions while keeping magnitude low. This provided four different stories: high outrage-high detail, high outrage-low detail, low outrage-high detail, and low outrage-low detail. A fifth story combined high magnitude with low outrage and low detail.

Subjects were 595 New Jersey middle-class residents (88% response from 676 contacts). A cluster sample was used to select households from four suburbs near Rutgers University that represented Middlesex County, i.e., not unduly full of students and professors. Interviewers alternated the type of subject asked for at each house by age (oldest vs. youngest over 18) and gender. The median age of the sample was 40 years; males were 45.5%; 29.6% had a high school education or less, and 16.6% had graduate school training. Sex and age were comparable to 1990 Census data (50% male; median age, 38), but recent data on education for these towns were not available. For the county as a whole, 53% of the population had up to a high school education and about 10% had graduate training. However, the county included a poor urban area not part of the sample area, so these data may underestimate the sample area's mean education levels. In short, the study sample was somewhat more female and perhaps better educated than the sampled population, with about the same age distribution.

Half of the subjects received the story first, then a six-item survey instrument, and finally a risk aversion/demographic questionnaire. The other half received the questionnaire first, then the story, and finally the survey instrument. No order effects were found. All subjects were asked to return the story before receiving the survey to avoid any rereading of the story in search of "correct" answers.

Results indicated that the technical detail manipulation did not significantly affect any dependent measure, including both perceived risk and intention to test well water, either alone or in a multiple regression analysis.[26] There was also no correlation between technical detail, as manipulated by researchers in different stories, and the manipulation check "perceived detail." Pretest results were thus confirmed. Technical detail was not perceptible and had no effect on risk perceptions within a range from typical journalistic reporting of technical information,"low", to the most detail an agency might reasonably expect a newspaper to include,"high". In contrast, "outrage" had strong, and risk magnitude weak, effects on risk perception.

Perceived detail, however, significantly correlated with ratings of the risk as serious ($r = 0.11$, $p < 0.05$). In the perceived risk multiple regression analysis, perceived detail was a statistically significant independent variable (Table 2). However, it contributed only 0.02 unique variance of a total adjusted squared multiple correlation of 0.25, the third independent variable to enter the regression after societal risk aversion and the perceived appropriateness of agency behavior. Perceived detail was not a significant factor in a multiple regression analysis for intention to test one's well water which, overall, explained only 14% of the variance. These analyses indicated that unknown factors not included in the regressions explained most of the variance in perceived risk and intention to test.

26 *See* Table 2 for variables used and results.

Table 2
Standardized Regression Coefficients, Proportion of Unique Variance and Significance Tests for Models Predicting Perceived Risk and Intention to Test

• Overall Model Tests •

Response Measure	*Adjusted Squared Multiple Correlation*	*F-Value*	*Signficance*
Perceived Risk	0.25	F(9,475) = 19.14	p < .0001
Intention To Test	0.14	F(10,449) = 8.69	p < .0001

• Unique Contribution Tests •

Test	*Stand. Regr. Coefficient*	*Unique Variance*	*F-Value*	*Signficance*
		• Perceived Risk •		
Age	–0.04	0.00	F(1,475) = 0.82	NS
Education	–0.11	0.01	F(1,475) = 8.01	p < .01
Sex	0.12	0.01	F(1,475) = 8.89	p < .01
Societal Risk Aversion	0.32	0.07	F(1,475) = 45.37	p < .001
Personal Risk Aversion	0.07	0.00	F(1,475) = 1.82	NS
Perceived Appropriateness	–0.23	0.04	F(1,475) = 23.65	p < .001
Perceived Detail	0.15	0.02	F(1,475) = 11.15	p < .001
Outrage	0.02	0.00	F(1,475) = 0.21	NS
Technical Detail	–0.02	0.00	F(1,475) = 0.31	NS
		• Intention to Test •		
Age	–0.05	0.00	F(1,448) = 1.43	NS
Education	0.27	0.07	F(1,448) = 35.91	p < .0001
Sex	–0.03	0.00	F(1,448) = 0.34	NS
Societal Risk Aversion	0.02	0.00	F(1,448) = 0.17	NS
Personal Risk Aversion	0.22	0.03	F(1,448) = 17.16	p < .0001
Perceived Appropriateness	–0.05	0.00	F(1,448) = 0.79	NS
Perceived Detail	0.03	0.00	F(1,448) = 0.41	NS
Perceived Risk	0.15	0.02	F(1,448) = 8.44	p < .01
Outrage	0.03	0.00	F(1,448) = 0.50	NS
Technical Detail	–0.01	0.00	F(1,448) = 0.01	NS

Perceived detail significantly correlated with the perceived appropriateness of agency behavior ($r = 0.44$, $p < 0.0001$). It also was affected by the outrage manipulation. People who read high-outrage stories saw them as containing much less detail [$F(1,495) = 10.61$, $p < 0.01$)] than did those who read low-outrage stories. Perhaps people concluded that proper agency behavior on other points implies sufficiently detailed information. The direction of causation here is speculative, however, since the research design could not assess temporal priority of variables. It is unclear, too, how much weight should be given any finding on perceived detail, a variable intended to measure the success of the technical detail manipulation but found to be unrelated to it. These results for perceived detail and perceived risk may seem to support Mazur's hypothesis[27] that people who see more information about a hazard will conclude that the risk must be more serious. Yet, the effect in this study was for perceived detail, not actual detail as in Mazur's hypothesis, and societal risk aversion had a greater effect on perceived risk. Thus it is still unclear whether Mazur's hypothesis, that overall media coverage even when positive increases perceived risk, can be extended to much narrower sharing of information, such as individual news stories.

Discussion

This is the first experimental proof that how an agency behaves (or at least is reported to behave) is at least as critical for public perceptions of risk and agency performance as what the agency says or is reported to say.[28] Outrage had a strong effect on risk perception through its shaping of perceived appropriateness of agency behavior, although it

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[27] Mazur, *supra* note 9.

[28] Whether these findings about media report effects reflect citizen reactions to actual agency statements and behavior was not studied here. However, personal experiences of the lead author and his colleagues in NJDEPE's Risk Communication Unit suggest that the two are similar, at least for high-outrage situations. In other words, when the agency engages in statements and other behavior seen as inappropriate by citizens, public perceptions of risk are high. This experience also suggests that low-outrage behavior by an agency reduces perceived risk, although the sample of low-outrage behavior is so small that this experience must be taken as suggestive only.

was not significant in the regression analysis unless perceived appropriateness was removed. In contrast, even five orders of magnitude of variance in risk magnitude had only modest effects on perceived risk, and there were no observable effects of technical detail. Perceived detail affected perceived risk, but far less than societal risk aversion and perceived appropriateness (Table 2). Furthermore, the significance of this relationship is unclear: perceived detail is not an obvious variable in actual environmental problems and debates among citizens and officials. Thus, the hypothesis that providing technical detail to citizens reduces perceived risk and increases perceived appropriateness of agency behavior received no support.

These results do not mean that transmission of technical information never has an effect. Clearly the confounding issues discussed earlier need to be explored in further research. These include the effects of different kinds of information; detail vs. story length; alarming or reassuring aspects of technical information; uncertainty; source credibility; channel effectiveness, e.g., press vs. television vs. personal interaction; and clarity of information. Information about PERC's carcinogenic potential appeared in this study's mock news stories. The study results suggest that alarm caused by such information, if any, can be reduced by "appropriate" agency behavior, although this needs further study. The strong effect of perceived appropriateness of agency actions on perceived risk suggests that the credibility of a given source may vary according to the messages it sends. It is not clear from this study whether agency credibility in the low outrage stories was due to the safety message contradicting expected messages from that source, as suggested earlier. For example, in the low-outrage condition the agency was willing to arrange further water testing and consider revising its standards; one result was lower perceived risk. The results may indicate that a government message can be credible because it treats citizen concerns as worthy of respect, rather than credibility stemming only from an admission that a situation is dangerous. These conflicting hypotheses must be tested directly.

When subjects in one pilot test were asked to assess the level of detail in paragraphs about health effects and exposure, they identified a difference in the first case but not the second. This different response to information on health effects and exposure routes may have been due to other differences between these topics. One study found that a large proportion, although not a majority, of the public does not recognize exposure as a necessary middle step in the process from pollutant emissions to health effects.[29] This view may make exposure routes less salient than health effects, and thus technical details about exposure less noticeable.

The perception of detail in individual paragraphs but not in entire stories in one pilot test also raises another issue. Suppose this lay inability to perceive differences in technical detail could be generalized across other topics, audiences, and information types and channels. As suggested earlier, this could result in either greater outrage, because government or other information sources seem unresponsive to requests for more information, or greater willingness to read technical details, because this reading does not seem demanding. These alternative hypotheses have important consequences for risk communication if they are true, so research on them seems needed.

Although the lack of effect found for technical detail variables considered jointly suggests a lack of individual effect, this is not conclusive. Different components of technical information may offset each other. For example, the information about possible health effects in both high- and low-detail stories may have aroused alarm, while the information that exposure routes posed no immediate problem may have allayed concern, assuming that people take exposure into account — a questionable assumption as noted earlier.

Another issue for further research is whether the problem is not so much that technical information is ineffective as that the wrong information is being provided (or recommended) by hazard managers. For example, studies have found that citizens stress facts other than mortality, e.g., catastrophic potential, transgenerational effects, and

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29 Nancy N. Kraus, Thorbjorn Malmfors & Paul Slovic. Intuitive Toxicology: Expert and Lay Judgments of Chemical Risks (Decision Research Report, 1990).

perceived scientific knowledge, in characterizing a hazard.[30] Providing technical information on these items might be more effective in addressing underlying public concerns than discussion of such mortality-related issues as exposure or health effects, although there is no evidence in favor of this hypothesis at present.

Conclusion

Many agency staff, corporate executives, and academic experts feel that giving citizens more detail about health effects data and likely exposure routes will reduce their concerns about low-probability risks. This study, although not definitive, suggests that providing more technical detail may not be the most useful strategy for risk communicators to pursue. In theory, both agency process (outrage) and science (technical detail) should help the public decide what risks are of concern. Yet officials who try to educate citizens on technical issues without also considering changes in their own behavior, e.g., more swiftly informing citizens how they are dealing with a problem and fully addressing public concerns, may do themselves a disservice.

Further efforts to explore the effects of technical information and its confounding variables on perceived risk could confirm how institutions can best address public concerns and the need for environmental education. Research on the causes and effects of perceived detail would help us understand what "useful technical information" means to citizens, as opposed to what it means to experts who try to provide it.

Appendix I
Simulated Stories Used in This Study

Three of the five simulated stories used in this study are reproduced on the following pages. They are, in sequence, the low outrage-high detail-low magnitude story; the high outrage-low detail-low magnitude story; and the low outrage-high detail-high magnitude story.

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30 For example, Slovic et al., *supra* note 1.

LIGHTNING STRIKE RELEASES CHEMICAL

No Health Threat Expected

MAPLE RIDGE — A lightning strike during last night's thunderstorm ruptured a chemical holding tank at Chemsol Inc., spilling a cancer-causing cleaning solvent called perchloroethylene onto neighboring residential lawns.

Perchloroethylene, more commonly called PERC, is a colorless liquid used as a cleaning agent or degreaser.

Chemsol, located on North Highway at Ridge Road, manufactures a range of chemical products used in dry cleaning and by the metal industries.

According to B.J. Chester, emergency response coordinator for the New Jersey Department of Environmental Protection, it was "a very unusual event" for lightning to cause a holding tank to burn and then rupture. the lightning apparently struck a valve right at the base of the tank, he said.

According to Chester, Chemsol's tanks meet all required standards. "We will certainly want to take another look at the regulations," Chester said. "Perhaps the agency should consider tougher standards for lightning protection." Chester said he would recommend that DEP consider requiring dikes around the tanks to prevent chemicals from escaping if there is a rupture.

About six families live less than a mile from the Chemsol holding tanks. The nearest family is a quarter mile away.

Neighbors said only about a third of the homes in the neighborhood draw their water from wells. Assuming this is true, Chester said, "two wells at most are facing a possible PERC contamination."

"Soon after I woke up there was a DEP person at my door explaining what happened and what the cleanup crews were doing." — Maple Ridge Resident

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Chester said DEP would be developing plans to test area wells for PERC. "At this point I wouldn't expect any wells to be seriously contaminated," Chester said. "But we still want to test to be sure."

Clara Stevenson, whose home is the closest one to the site of the spill, said she was "impressed" by DEP's promise to test her well. "I'm much less upset now that I have talked to the DEP people," she said.

Scientific research has linked long-term PERC exposure to liver cancer in mice and leukemia in rats. Although no evidence has been found concerning cancer in humans, EPA considers PERC a "suspected human carcinogen." State standards for PERC permit no more than one part per billion in drinking water.

Although not all scientists agree, it is estimated that an average adult who drank PERC contaminated water for an entire lifetime at the highest level of PERC allowed under government standards would have an increased cancer risk of up to one in a million as a result.

Chester said the spill did not pose any risk of breathing in PERC contaminated air, because the PERC in the puddles would spread quickly as soon as it reached the air, and would "almost immediately" become much too dilute to endanger anyone's health.

He said the only way local residents might get a significant short-term PERC exposure from the spill was by drinking water from the puddles or direct skin contact with the puddles. He advised residents to keep children and pets out of the puddles until they have had a chance to evaporate.

He said the possible longer-term risk to residents with wells near the spill could not be estimated yet. "The risk to any particular well depends on the amount of PERC spilled, how close the spill is to the well, and what sort of soil separates the PERC from the well," he explained.

DEP tested puddle water on the Chemsol site last night and plans to test again today, but the results won't be back from the laboratory for two to three weeks, Chester said. Water samples were also taken from nearby lawns.

He said that preliminary data "which will have to be confirmed" indicated that last night's levels in neighborhood puddles were probably above the state drinking water standard, "perhaps as high as five parts per billion," five times the standard. He said it was not possible to estimate how much of the PERC might eventually soak down to well water, "but it would surely be much less than in the puddles."

According to the U.S. Environmental Protection Agency's Office of Drinking Water, short-term exposure to breathing high levels of PERC can cause a wide range of health effects.

However, Chester said these effects would result only from breathing in concentrated PERC vapors, and could not happen to Maple Ridge residents.

He said DEP had made arrangements with the county health department to check with the nearest residents later today to make sure they have no symptoms of overexposure. "Even though we are fairly confident that at the levels we think are present no symptoms are likely," he said, "checking with people is a way to make sure and at the same time answer their questions."

"Soon after I woke up there was a DEP person at my door explaining what happened and what the cleanup crews were doing," said Maple Ridge resident Alex Sands.

LIGHTNING STRIKE RELEASES CHEMICAL

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MAPLE RIDGE — A lightning strike during last night's thunderstorm ruptured a chemical holding tank at Chemsol Inc., spilling a cancer-causing cleaning solvent called perchloroethylene onto neighboring residential lawns.

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Chemsol, located on North Highway at Ridge Road, manufactures a range of chemical products used in dry cleaning and by the metal industries.

According to B.J. Chester, emergency response coordinator for the New Jersey Department of Environmental Protection, it was "a very unusual event" for lightning to cause a holding tank to burn and then rupture. The lightning apparently struck a valve right at the base of the tank, he said.

According to Chester, Chemsol's tanks meet all required standards. "It looks like a fluke to me," Chester said. "As far as I know, DEP has no plans to reexamine the regulations. You can't cover every conceivable event." Chester said he would not recommend that DEP consider requiring dikes around the tanks to prevent chemicals from escaping if there is a rupture.

About six families live less than a mile from the Chemsol holding tanks. The nearest family is a quarter mile away.

Neighbors said only about a third of the homes in the neighborhood draw their water from wells. Assuming this is true, Chester said, "two wells at most are facing a possible PERC contamination."

"I have no idea what happened or what they're doing about it, and nobody from DEP is taking the time to tell me." — Maple Ridge Resident

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Chester said DEP had no plans to test area wells for PERC. "At this point I wouldn't really expect any wells to be seriously contaminated," Chester said. "People who want to be sure will have to make their own arrangements."

Clara Stevenson, whose home is the closest one to the site of the spill, said she was "furious" about DEP's unwillingness to test her well. "My whole family is upset and the DEP people just don't seem to care," she said.

Scientific research has linked long-term PERC exposure to some kinds of cancer in test ani-mals. State standards for PERC permit no more than one part per billion in drinking water.

Although not all scientists agree, it is estimated that an average adult who drank PERC contaminated water for an entire lifetime at the highest level of PERC allowed under government standards would have an increased cancer risk of up to one in a million as a result.

Chester said the spill did not pose any risk of breathing in PERC contaminated air, only a possible water problem. He advised residents to keep children and pets out of the puddles until they have had a chance to evaporate. He said the possible longer-term risk to residents with wells near the spill could not be estimated yet.

DEP tested puddle water on the Chemsol site last night and plans to test again today, but the results won't be back from the laboratory for two to three weeks, Chester said. Water samples were also taken from nearby lawns.

He said that preliminary data "which will have to be confirmed" indicated that last night's levels in neighborhood puddles were probably above the state drinking water standard, "perhaps as high as five parts per billion," five times the standard. He said it was not possible to estimate how much of the PERC might eventually soak down to well water, "but it would surely be much less than in the puddles."

According to the U.S. Environmental Protection Agency's Office of Drinking Watér, short-term exposure to breathing high levels of PERC can cause a wide range of health effects.

However, Chester said these effects would result only from breathing in concentrated PERC vapors, and could not happen to Maple Ridge residents.

He said there was no need to check for symptoms in nearby residents, because "we are fairly confident that at the levels we think are present no symptoms are likely." Asking an expert to check with people, he said, "would be a senseless use of overtaxed agency resources and might just provoke hysterical responses in people who are not really at any risk."

"I have no idea what happened or what they're doing about it, and nobody from DEP is taking the time to tell me," said Maple Ridge resident Alex Sands.

LIGHTNING STRIKE RELEASES CHEMICAL

Health Threat Expected

MAPLE RIDGE — A lightning strike during last night's thunderstorm ruptured a chemical holding tank at Chemsol Inc., spilling a cancer-causing cleaning solvent called perchloroethylene onto neighboring residential lawns.

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According to Chester, Chemsol's tanks meet all required standards. "We will certainly want to take another look at the regulations," Chester said. "Perhaps the agency should consider tougher standards for lightning protection." Chester said he would recommend that DEP consider requiring dikes around the tanks to prevent chemicals from escaping if there is a rupture.

About 200 families live less than a mile from the Chemsol holding tanks. The nearest family is only 100 yards away.

Neighbors said virtually all the homes near the spill draw their water from wells. Assuming this is true, Chester said, "all 200 wells face a possible PERC contamination."

"Soon after I woke up there was a DEP person at my door explaining what happened and what the cleanup crews were doing." — Maple Ridge Resident

Chester said DEP would be developing plans to test area wells for PERC. "At this point I wouldn't really expect any wells to be seriously contaminated," Chester said. "But we still want to test to be sure."

Clara Stevenson, whose home is the closest one to the site of the spill, said she was "impressed" by DEP's promise to test her well. "I'm much less upset now that I have talked to the DEP people," she said.

Scientific research has linked long-term PERC exposure to liver cancer in mice and leukemia in rats. Although no evidence has been found concerning cancer in humans, EPA considers PERC a "suspected human carcinogen." State standards for PERC permit no more than one part per billion in drinking water.

Although not all scientists agree, it is estimated that an average adult who drank PERC contaminated water for an entire lifetime at the highest level of PERC allowed under government standards would have an increased cancer risk of up to one in 10,000 as a result.

Chester said the spill did not pose any risk of breathing in PERC contaminated air, because the PERC in the puddles would spread quickly as soon as it reached the air, and would "almost immediately" become much too dilute to endanger anyone's health.

He said the only way local residents might get a significant short-term PERC exposure from the spill was by drinking water from the puddles or direct skin contact with the puddles. He advised residents to keep children and pets out of the puddles until they have had a chance to evaporate.

He said the possible longer-term risk to residents with wells near the spill could not be estimated yet. "The risk to any particular well depends on the amount of PERC spilled, how close the spill is to the well, and what sort of soil separates the PERC from the well," he explained.

DEP tested puddle water on the Chemsol site last night and plans to test again today, but the results won't be back from the laboratory for two to three weeks, Chester said. Water samples were also taken from nearby lawns.

He said that preliminary data "which will have to be confirmed" indicated that last night's levels in neighborhood puddles were probably above the state drinking water standard, "perhaps as high as 100 parts per billion," a hundred times the standard. He said it was not possible to estimate how much of the PERC might eventually soak down to well water, "but it would surely be much less than in the puddles."

According to the U.S. Environmental Protection Agency's Office of Drinking Water, short-term exposure to breathing high levels of PERC can cause a wide range of health effects.

However, Chester said these effects would result only from breathing in concentrated PERC vapors, and could not happen to Maple Ridge residents.

He said DEP had made arrangements with the county health department to check with the nearest residents later today to make sure they have no symptoms of overexposure. "Even though we are fairly confident that at the levels we think are present no symptoms are likely," he said, "checking with people is a way to make sure and at the same time answer their questions."

"Soon after I woke up there was a DEP person at my door explaining what happened and what the cleanup crews were doing," said Maple Ridge resident Alex Sands.

Appendix II

Research Questionnaire

INSTRUCTIONS: Please answer the following questions based on your impressions from the story you just read. We want to know *your* impressions from the story.

Please check the response that best gives your impressions of the situation in the story. If you have no opinion, then check "No Opinion."

For example, in the sample item below, assume that after reading the story your impression was that the story was better than "a little well written," but not as good as "well written." Then you would check the response "moderately well written" as shown below in Sl.

Sl. How well written do you think the story is?

not at all well written	a little well written	moderately well written	well written	very well written	extremely well written	no opinion
[]	[]	[x]	[]	[]	[]	[]

1. What is your impression of how serious this situation is?

not at all serious	a little serious	moderately serious	serious	very serious	extremely serious	no opinion
[]	[]	[]	[]	[]	[]	[]

2. How appropriate was DEP's handling of the PERC spill?

not at all appropriate	a little appropriate	moderately appropriate	appropriate	very appropriate	extremely appropriate	no opinion
[]	[]	[]	[]	[]	[]	[]

3. How detailed was the information in the story about the health effects of the PERC spill and the ways people might get exposed?

not at all detailed	a little detailed	moderately detailed	detailed	very detailed	extremely detailed	no opinion
[]	[]	[]	[]	[]	[]	[]

4. If you lived in the area, how worried would you be about the risk from the PERC spill?

not at all worried	a little worried	moderately worried	worried	very worried	extremely worried	no opinion
[]	[]	[]	[]	[]	[]	[]

5. If you lived in the area, how willing would you be to spend $500 to have your water tested for PERC contamination after the spill?

not at all willing	a little willing	moderately willing	willing	very willing	extremely willing	no opinion
[]	[]	[]	[]	[]	[]	[]

6. How important do you consider the risk posed by this situation?

not at all important risk	a little important risk	moderately important risk	important risk	very important risk	extremely important risk	no opinion
[]	[]	[]	[]	[]	[]	[]

(Over)

For each statement below, please check the response that *best* indicates how much you agree or disagree.

For example, in the sample item below, if you believed that voters are unconcerned about environmental issues, then you would check the response "agree" as shown below in S2.

S2. Environmental issues are of little concern to the voters.

very strongly disagree	strongly disagree	disagree	neutral	agree	strongly agree	very strongly agree
[ ]	[ ]	[ ]	[ ]	[x]	[ ]	[ ]

1. The public has a right to demand *zero* risk from industry.

very strongly disagree	strongly disagree	disagree	neutral	agree	strongly agree	very strongly agree
[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

2. If there was even the *slightest* amount of asbestos in my home, I would remove it.

very strongly disagree	strongly disagree	disagree	neutral	agree	strongly agree	very strongly agree
[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

3. I try to avoid *all* food additives and preservatives.

very strongly disagree	strongly disagree	disagree	neutral	agree	strongly agree	very strongly agree
[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

4. An industry that pollutes shouldn't be allowed to stay open, no matter *how little* pollution it produces.

very strongly disagree	strongly disagree	disagree	neutral	agree	strongly agree	very strongly agree
[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

To help us describe participants in the study, please tell us:

1. Your sex (Check one)

Male	Female
[ ]	[ ]

2. Your age (Check one)

18-22	23-27	28-32	33-37	38-42	43-47	48-52	53-57	58-62	Over 62
[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]	[ ]

3. How much school have you completed? (Check one)

[ ] Some grade school
[ ] Some junior high school
[ ] Some high school
[ ] Finished high school
[ ] Some college
[ ] Finished 2-year college
[ ] Finished 4-year college
[ ] Some graduate study
[ ] Graduate degree

THANKS FOR YOUR HELP!!