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CHANGES IN RISK PERCEPTION OVER TIME *

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LEO S. GOMEZ
Sandia National Laboratory
Albuquerque, New MexicoHANK C. JENKINS-SMITH
University of New Mexico
Albuquerque, New MexicoKENNETH W. MILLER
University of New Mexico
Albuquerque, New Mexico

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1. Introduction

The focus of this paper is on changes in perceptions of the risks associated with nuclear waste management over time. In particular, we are interested in the kinds of change that take place when the management programs, and those who are charged with implementing them, are subject to intensive public debate over an extended period of time.

The study of perception of risks associated with nuclear waste management is especially interesting in New Mexico and Colorado, since both states are involved in the production, transportation and disposal of nuclear wastes. In Colorado the operation of the Rocky Flats plutonium production facility (RFP) has been of public concern for many years. A recent event which attracted national media attention was the raid by federal agents of the RFP on June 6, 1989. That raid, called Operation Glowing Desert, resulted in a partial closing of the plant and in the replacement of the RFP operating contractor (Sloan, 1990). Since Rocky Flats is allowed to accumulate only so much nuclear waste, those wastes must be shipped to other sites for permanent storage or disposal. The U.S. Department of Energy (DOE) intends to open a permanent disposal site in New Mexico, the Waste Isolation Pilot Plant (WIPP), where transuranic nuclear wastes generated by defense programs are to be stored 655 meters below the surface in bedded salt formations. However, the opening of WIPP has been delayed for a variety of reasons, including intense political opposition. Meanwhile, the accumulation of nuclear waste at RFP is nearing its maximum allowable level.

In New Mexico the operation of the Los Alamos National Laboratory (LANL), Sandia National Laboratories (SNL), and the anticipated opening of the WIPP have been of public concern. Reporting of releases of radionuclides into canyons adjacent to LANL, the proposed release of slightly radioactive water by SNL into the Albuquerque sanitary sewer system, and public meetings discussing proposed transportation routes through New Mexico to the WIPP site has focused and sustained public attention on nuclear waste matters. In both Colorado and New Mexico, various local and national environmental groups have played leading roles in calling attention to potential risks associated with these nuclear waste issues and in demanding that the risks be mitigated or eliminated (see, e.g., Hancock, 1989).

The news media in both states devote much attention to the reporting of activities at RFP, LANL, SNL and WIPP. The citizens of Colorado and New Mexico, therefore, are exposed to many arguments on both sides of nuclear waste management issues. For these reasons, the residents of Colorado and New Mexico make appropriate populations in which to examine *changes* in the perceptions of risk associated with nuclear waste management that may result from extended political debate.

We have undertaken an over-time study of perceived risks in Colorado and New Mexico by implementing sequential random household surveys in each state, timed at six month intervals. This study employs three of these surveys, spanning the period from summer, 1990 to summer, 1991. Using these data, we examine the dynamics that may underlie variations in perceived risks over time. In particular, our analysis is focused on changes in the roles played by (a) basic political orientations (i.e., political ideology) and (b) trust in those who advocate conflicting policy positions. Our results indicate that, while overall levels of perceived risk may appear to be remarkably stable, the underlying factors associated with those perceptions are subject to substantial change. More specifically, as the policy

disputes over nuclear policies drag on, perceptions of risk become increasingly associated with political ideology and levels of trust in the major policy advocates. These results indicate that, the longer a public debate over nuclear waste policy endures, the greater will be the role played by conventional political variables in shaping perceived risks. The associated implication is that the role of dispassionate "risk assessment" in shaping perceptions and policy preferences may well *decline* as the debate drags on.

2. Hypotheses

Recent research on public perceptions of risk associated with the Nevada Yucca Mountain high-level nuclear waste storage facility has demonstrated significant dread of, and opposition to, the Yucca Mountain facility among Nevada citizens (Slovic, Flynn and Layman, 1991; Mountain West Research, 1989). In addition, research on perceptions of risk in Colorado and New Mexico has analyzed the ways in which trust, ideology, and other factors may influence perceptions of the risks of radioactive waste management (Jenkins-Smith, Espey, Rouse and Molund, 1991; Smith and Jenkins-Smith, 1991; Barke, Jenkins-Smith and Rouse, 1991). In general, this research has tended to focus on analysis of risk perception within a population, or across different populations, at a given time. By contrast, the present research is concerned with what sorts of *changes* take place in the bases for perceived risk when a public is exposed to prolonged and contentious debate over nuclear waste policy issues. Do individuals begin with a relatively complete "schema" or set of beliefs with which to make judgments about risk, or do they develop some sort of a schema over the course of the policy debate? If the former is the case, static analyses should do a decent job of isolating the factors that underlie risk perceptions generally. If, on the other hand, the bases for nuclear risk perceptions evolve over time we might find that citizens respond to one sort of cues or associations at an early stage in the debate, and quite another at a later date.

Our general hypothesis is that lay citizens undergo a significant change in the manner in which they formulate judgments about risk as they are exposed to a stream of information and feedback about nuclear risks over time. That change might operate something like this: at the earlier stages of the policy debate, individuals have only rudimentary means to attach perceptions of risk to other, more familiar constructs that typically form the basis of political judgments.¹ In a relative information vacuum, they have little systematic means to organize and make sense of a new policy dispute. The average citizen has little idea of who is on which side, or what is at stake. In the absence of more specific cues regarding how to fit the new issue into existing political or policy cosmologies, an individual will rely on the most general sentiments or images in making a judgment about risks.² This situation changes as new bits and streams of information are encountered, typically in the

¹ Daniel Yankelovich (1991) has argued that "public opinion" differs significantly from "public judgment." We agree that the *qualities* of public opinion can vary substantially, and argue that exposure to an extended policy debate can affect those qualities. We expect that risk perceptions and related policy positions regarding potentially hazardous facilities are subject to these changes. We *do not* mean to argue, however, that exposure to an extended public debate will lead to public judgment as defined by Yankelovich. Our apologies to Yankelovich for using a looser and more permissive definition of "judgment" in this paper.

² Kuklinski et al (1982), in a study of attitudes toward nuclear power, found that "more knowledgeable" individuals tended to rely on ideology in formulating policy positions, while "less knowledgeable" persons relied on more general concepts about the beneficence of science and technology. This pattern fits the more general distinction we are making here, except that we are addressing the diffusion of a kind of knowledge throughout a population.

mass media. Statements by various identifiable political elites or interest groups help place the issue into more familiar conceptual terrain, and political argument begins to attach the issue to more complex political concepts. For many people, interaction with friends or coworkers may serve to provide further coherence to the issue (MacKuen and Brown, 1987). In the process an "issue context" begins to take shape (Wildavsky, 1962), sides become identified, and the issue becomes attached to familiar political constructs such as "liberal," "conservative," "pro-business" or "pro-environment." At this stage the judgment of risk will be much more clearly linked to general political constructs and beliefs. This linkage would become stronger, and perceptions of risk more tightly nested within broader political orientations, as the policy debate is carried on.³

Our specific hypotheses are derived from this general conception of the changing qualities of judgments about nuclear risk over time. Of course, no data set could include a sufficient array of variables to permit a test of all the changing attributes that would potentially characterize the place of risk perceptions within an evolving issue context. However, several of the measures within our series directly apply. First, each of our surveys contains an array of demographic attributes. As a comparative control, we would expect relatively little change in the influence of such variables. Indeed, these are precisely the kinds of attributes that we would expect to be *relatively* influential in the earlier stages of the policy debate, when most individuals' issue contexts are less conceptually developed. Thus, we hypothesize that we will see relatively little change in the pattern and magnitude of relationships between the demographic variables and nuclear risk perception.

Second, we expect to see a discernible increase in the importance of political ideology as a predictor of risk perception over the time series. This follows from the contention that, as the policy debate progresses, individuals become better able to employ this familiar political orientation in making judgments about policy-relevant risks.

Third, we hypothesize that the role of trust in prominent players in the policy debate as a predictor of risk perceptions will grow significantly over the time series. Again, the progress of the policy debate permits people to make increasingly refined connections between trusted or distrusted elites and judgments about risk. We are not arguing that the levels of trust in specified policy elites will change over the course of the debate (though the debate may well be directed at *who* is worthy of trust), but that levels of trust in specific elites will become more important ingredients in formulations of risk perceptions.

Thus we select two elements of the general political cosmology -- political ideology and trust in prominent policy elites -- that we would expect to become of increasing importance as the bases of judgments about risk are modified by continuing exposure to the policy debate, and examine their relationships to perceived risk over time. By contrast, we examine the role of an array of demographic variables -- sex, age, education level, and income -- over the series as variables that we do not expect to play an increasing role in shaping risk perceptions.

³ Of course it is probable that this process of fitting a new issue about risk into familiar political cosmologies will change that cosmology. In general, however, we would expect that for most individuals that change in the broader cosmology would be incremental, with the prior beliefs and attitudes acting as constraints on positions or judgments taken with respect to the new issue. For discussions of belief systems and how they may change when confronted by new information, see Axelrod (1980) and Sabatier (1988).

3. Data and Method

This project is designed to tap perceptions of, and beliefs about, nuclear risks among the general populations of Colorado and New Mexico. The research design involves the collection of a series of independent samples of interviews with voting-age respondents from randomly selected households in Colorado and New Mexico.⁴ Using telephone surveys, random samples of interviews have been collected in summer 1990, winter 1990-91, and summer 1991.⁵ Each sample consists of over 1200 interviews. With data from these three surveys, we are able to assess patterns of change across two time periods, equivalent to one year (summer 1990 to summer 1991).

The survey data were collected by the UNM Survey Research Center's computer aided telephone interviewing laboratory. The samples were based on stratified random digit dialing sample frames, in order to assure adequate regional representation of respondents from both Colorado and New Mexico. Sample response rates⁶ ranged from 25% in the Winter, 1990-91 survey to 26.1% in the Summer, 1991 survey. To date, over 3,600 interviews have been collected for this project.

As described above, this analysis seeks to explain variations in the perception of risk over time associated with nuclear waste management. In order to tap this perception, we employed survey questions that are designed to measure perceived risk across four specific stages of the nuclear waste management process: the production of nuclear energy, temporary storage of nuclear waste, transportation of nuclear waste, and permanent storage of nuclear waste. For each of these stages, we asked our respondents to indicate the level of perceived risk on a five point Likert-type scale, ranging from "extreme risk" to "no risk". For this analysis, we use the measures of the two types of risk that have figured most prominently in the Colorado/New Mexico policy debates: risks of the transportation and permanent storage of the nuclear wastes.

In order to obtain indicators of the degree of trust held for different actors who are prominent in the nuclear waste debate in Colorado and New Mexico, we asked the respondents to indicate how much trust they would place in statements made by various actors about a controversial nuclear waste policy decision, based on a ten point scale ranging from "not at all trustworthy" to "completely trustworthy".⁷ Included in this analysis are the trust scores for the U.S. Department of Energy, national environmental groups, and representatives of the U.S. national laboratories (SNL and LANL). As indicated in the introduction to this paper, each of these groups has played a substantial role in the policy debate over nuclear waste management, and each has a fairly clearly articulated position within that debate.

⁴ Respondents are randomized within households by asking to interview the household member with the "most recent birthday."

⁵ A winter, 1991-92 survey is underway at the time of this writing, and another one is planned for summer, 1992.

⁶ Calculated as completed interviews divided by completed interviews + refusals + "no answers" + "busy" responses.

⁷ The winter 1990-91 survey used a scale ranging from 0 to 10. These scores were recoded to make them comparable with those of the earlier surveys.

Because one important question concerns the (possibly changing) role of basic political attitudes in shaping perceptions of nuclear risk over the course of an extended policy debate, we included a political ideology measure. The respondents were asked to place themselves on a seven-point ideology scale, ranging from "extremely liberal" to "extremely conservative".

Finally, in order to control for a range of underlying demographic factors, we included a set of measures of basic demographic attributes. Included are measures of the respondents' age, income, education level, and gender. As noted earlier, these variables were included to control for factors that we would expect to have roughly constant effects on perceived risk over the course of the debate. However, as we will discuss in section __ of this paper, one of these factors -- level of education -- gives evidence of having played an increasingly important role in shaping risk perception over time. The exact question wording for each of the variables included in this analysis is shown in Appendix A.

4. Changes in Perceived Risk Over Time

Before testing our specific hypotheses, it is useful to briefly assess overall changes in perceived risks over the period of this analysis. As noted above, Coloradans and New Mexicans have been treated to an extensive, prominent and sometimes acrimonious debate over the nuclear waste problems associated with Rocky Flats, the national laboratories (SNL and LANL), and transportation and disposal of nuclear wastes at the WIPP facility. Given the findings of the literature on "risk amplification" (Kasperson et al, 1990) and the general role played by the new media (Rothman and Lichter, 1987; Harvard piece, 1990), we would expect public perception of risk to have grown significantly over time.

What has been the measurable effect, if any, of this debate on perceptions of risk? Our measures indicate that, on the surface at least, change in perceived risks of nuclear waste management has been remarkably modest. Table 1 reports the average risk perception measures for transportation and permanent storage of nuclear wastes. The scores represent a range from 1 ("extremely risky") to 5 ("not at all risky"). Because the focus of the policy debate and media attention can be expected to differ in the two states,⁸ the values are shown separately for respondents from Colorado and New Mexico. As shown in Table 1, among Colorado respondents the average perception of the risk of nuclear waste transportation held fairly constant, ranging from a value of 1.93 in the summer of 1990 to a value of 1.91 in the summer 1991. Permanent storage of nuclear wastes was generally perceived as less risky than transportation, with Colorado scores ranging from 2.16 in the summer of 1990 to a slightly riskier 2.02 in the summer of 1991.

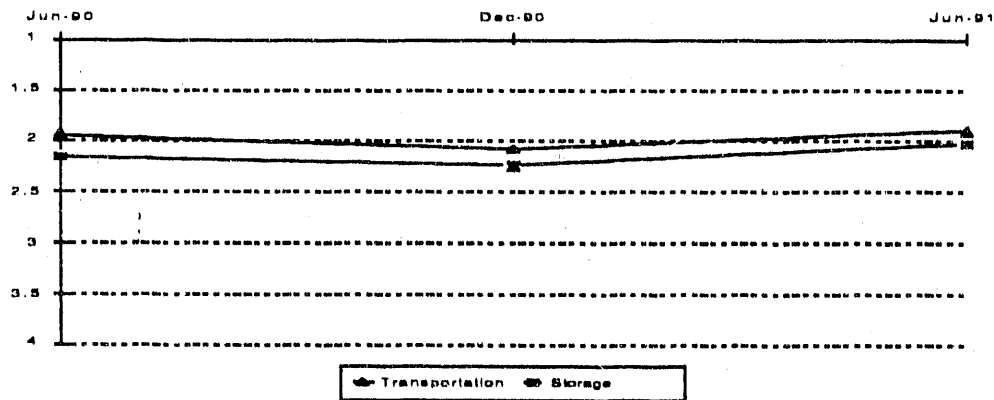
Table 1: Change in Perceived Risk Over Time

(total sample size=3558)

	Summer '90		Winter '90		Summer '91	
	<u>Colorado</u>	<u>New Mexico</u>	<u>Colorado</u>	<u>New Mexico</u>	<u>Colorado</u>	<u>New Mexico</u>
Transportation	1.93	2.17	2.08	2.09	1.91	2.15
Permanent Storage	2.16	2.35	2.25	2.26	2.02	2.25

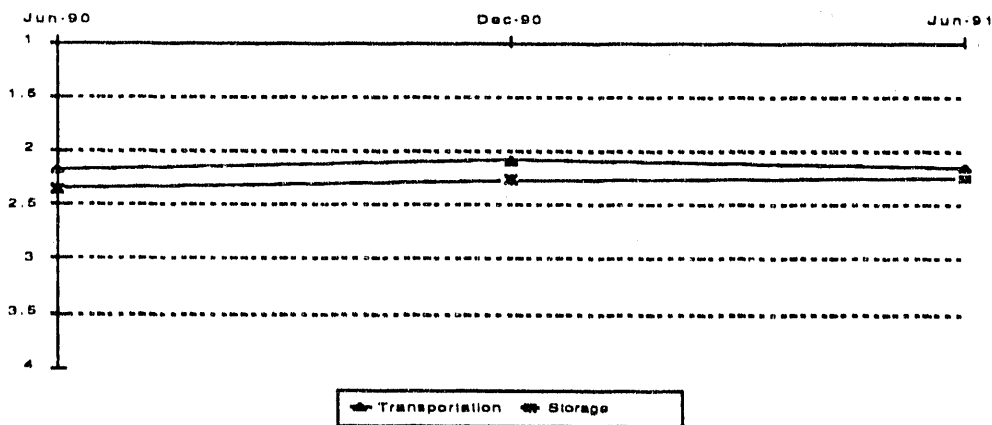
⁸ Coloradans would be expected to have heard more about the problems at Rocky Flats, while New Mexican are more likely to have been exposed to more debate over WIPP.

Figure 1: Perceptions of Nuclear Waste Transportation and Storage in Colorado: June 1990-June 1991



New Mexico respondents tended to perceive less risk than did those from Colorado, though the values nearly converged in the winter of 1990-91. Transportation risk was pegged at 2.17 in the summer of 1990, and after an upsurge in perceived risk in the winter of 1990-91, returned to 2.15 in the summer of 1991. As was the case with the Coloradans, New Mexicans saw storage as less risky than transportation, with an average value of 2.35 in the summer of 1990 declining to 2.25 by summer of 1991. These changes in perceived risk are depicted in Figures 1 and 2.

Figure 2: Perceptions of Nuclear Waste Transportation and Storage in New Mexico: June 1990-June 1991



Overall, the average scores from the three time periods give evidence of remarkable stability in perceived risk of transportation or storage in nuclear wastes. Where change *is* evident, the data suggest a slight trend toward perceptions of greater risk. However, the apparent stability in perceived risk may be misleading; akin to the surface of a body of water, wherein level does not change but the dynamics under the surface -- flow, temperature, stratification -- may be subject to substantial changes. In order to ascertain whether such "subsurface" change is evident, we begin by analyzing patterns of change in *who* perceives what level of risk.

5. Demographic Bases for Risk Perception

The research on risk has frequently noted systematic variations in risk perceptions associated with demographic attributes, if only in passing (see, e.g., Mushkatel et al, 1991; for more specific research on risk and gender, see Espey, 1992). Our interest in the associations among demographic attributes and risk perception stems in part from the need to use these associations to hold constant such factors as gender and age, in order to be able to focus more specifically on changes in the roles of ideology and trust over time. Using multivariate regression analysis, the relationships between education, income, age, gender, and state of residence (Colorado or New Mexico) on the perceived risks of transporting and storing nuclear wastes were estimated. The results are shown in Tables 2 and 3.

Table 2: Demographic Explanations of Perceptions of the Risks of Transportation of Nuclear Waste

	Summer '90 (std.coeff.)	Winter '90 (std.coeff.)	Summer '91 (std. coeff.)
EDUCATION	0.049	0.055*	0.080**
INCOME	0.093**	0.087**	0.089**
AGE	0.096***	0.132***	0.102***
GENDER	-0.216***	-0.232***	-0.183***
STATE (1=Colorado)	-0.118***	-0.000	-0.127***
	R ² =0.87	R ² =0.094	R ² =0.085

Note: * denotes statistical significance at the 0.05 level
 ** at the 0.01 level
 *** at the 0.001 level

The explanatory power of the demographic variables for perceived risks of the transportation of nuclear waste was quite constant over the time span of this analysis. As indicated by the R²s for each of the three time periods in Table 2, these variables were able to account for roughly 9% of the variation in perceived risks in each case. Age and gender were highly statistically significant predictors of perceived risk in each case. Women and younger respondents tended to perceive significantly greater risks than males and older respondents. Interestingly, level of education appears to have had an increasing association with perceived risk over time, with standardized coefficients rising from 0.049 in summer, 1990 to 0.080 in summer 1991. Thus, over the course of the year, higher levels of education appear to have become increasingly associated with perceptions of less risk. And, as indicated by the STATE variable, Coloradans perceived greater risks than New Mexicans in the summers of 1990 and 1991, though levels of perceived risk across the two states converged in the winter of 1990-91.

A similar pattern is evident regarding the perceived risks of nuclear waste storage. In each time period, the demographic variables are estimated to explain roughly 6% to 7% of the variance in risk perception. Women perceived greater risk than men, and older respondents perceived less risk than younger ones. Again, education levels (and, to a lesser extent, income levels) appear to have become increasingly associated with perceived risks over the time series, with higher levels of education (and income) being tied to the perception of less risk.

Table 3: Demographic Explanations of Perceptions of the Risks of Permanent Storage of Nuclear Waste

	Summer '90 (std.coeff.)	Winter '90 (std.coeff.)	Summer '91 (std. coeff.)
EDUCATION	0.047	0.059*	0.117***
INCOME	0.057	0.055	0.086**
AGE	0.119***	0.124***	0.111***
GENDER	-0.198***	-0.184***	-0.129***
STATE (1=Colorado)	-0.088**	0.001	-0.115***
	R ² =0.070	R ² =0.063	R ² =0.075

Note: * denotes statistical significance at the 0.05 level
 ** at the 0.01 level
 *** at the 0.001 level

For the most part, these findings are consistent with our hypothesis that demographic attributes would have a relatively constant effect on risk perceptions over the course of a policy debate. The chief exception is education, which appears to have had an increasing effect on (dampening) risk perceptions over time. This may indicate that social class attributes, like education and income, act differently than more directly biological attributes like age or sex difference.

6. Ideological Orientations and Risk Perception

We hypothesized that general political constructs, like ideology, would have increasing effects on perceived risks over the course of the policy debate. To test this hypothesis, we modeled the relationship between ideology and risk perceptions, controlling for demographic attributes. The results for the perceived risks of transportation and permanent storage of nuclear wastes are shown in Tables 4 and 5.

Table 4: Political Ideology and Perceptions of the Risks of Transportation of Nuclear Waste

	Summer '90 (std.coeff.)	Winter '90 (std.coeff.)	Summer '91 (std. coeff.)
EDUCATION	0.052	0.067*	0.091**
INCOME	0.091**	0.084**	0.077*
AGE	0.095***	0.119***	0.093***
GENDER	-0.216***	-0.232***	-0.172***
STATE (1=Colorado)	-0.119***	-0.005	-0.128***
IDEOLOGY	0.020	0.075**	0.154***
	R ² =0.088	R ² =0.101	R ² =0.109

Note: * denotes statistical significance at the 0.05 level
 ** at the 0.01 level
 *** at the 0.001 level

If political ideology has an increasing effect on nuclear risk perceptions over time, we should see its contribution to the explanatory power of the model grow over time. This is precisely the pattern seen here. By adding ideology to the basic demographic variables, the R²s for the models of transportation risk perception increase by 1% in the first sample, 7% for the second sample, and 28% for the third sample. Thus, from virtually no effect in the first sample, political ideology increases the size of the R² by over one quarter in the third sample. Inspection of the standardized coefficients tells the same story; ideology has a statistically insignificant effect in the summer, 1990, sample, but becomes significant in the winter, 1990-91 sample, and grows substantially (to become second in magnitude only

to gender) in the summer, 1991 sample. In each case, the sign on the estimated coefficient indicates that the closer to the "conservative" side of the ideology scale, the less risk is perceived in transportation of nuclear wastes.

Table 5: Political Ideology and Perceptions of the Risks of Permanent Storage of Nuclear Waste

	Summer '90 (std.coeff.)	Winter '90 (std.coeff.)	Summer '91 (std. coeff.)
EDUCATION	0.055	0.077*	0.120***
INCOME	0.050	0.059	0.077**
AGE	0.114***	0.115***	0.100***
GENDER	-0.199***	-0.181***	-0.114***
STATE (1=Colorado)	-0.089**	-0.001	-0.118***
IDEOLOGY	0.069*	0.078**	0.136***
	R ² =0.075	R ² =0.073	R ² =0.092

Note: * denotes statistical significance at the 0.05 level
 ** at the 0.01 level
 *** at the 0.001 level

The same pattern is evident with respect to the perceived risks of the permanent storage of nuclear wastes. Comparing the R² in Tables 3 and 5, we find that the explanatory power of the model grows by 7%, 16% and 23% across the summer 1990, winter 1990-91 and summer 1991 samples, respectively. Again, the magnitude of the estimated standardized coefficients for ideology increase significantly from the first to the third sample. With regard to the perceived risks of storage, however, the size of the estimated effects of ideology are larger than those of any of the included demographic variables by summer, 1991. These results provide significant evidence that the importance of ideology as a factor shaping risk perception grows over time in a nuclear risk policy debate.

7. Trust in Policy Elites and Risk Perception

Our argument has been that citizens will increasingly integrate judgments about nuclear risk with more familiar elements of their political cosmologies as the policy debate adds clues about relevant political constructs and the positions of familiar policy elites. If correct, we should find that levels of trust in the various leading players in the policy debate becomes an increasing factor over time in shaping risk perceptions.

Before analyzing the influence of trust on risk perceptions, in Table 6 we present the average trust scores for three prominent policy players in the Colorado/New Mexico nuclear waste policy debate -- the national laboratories, the Department of Energy, and national environmental groups. In each sample, respondents were asked to indicate the level of trust they would give statements about a controversial nuclear policy decision made by spokespersons from each of these organizations. As evident in Table 6, trust for the national laboratories declined sharply from summer 1990 to winter 1990-91, and partially recovered by summer 1991. The same "bounce," though less pronounced, is evident for the national environmental groups. Trust in the Department of Energy, on the other hand, appears to have increased over the year, with the greatest increase in New Mexico. Whether these changes constitute significant trends won't be known until more time periods are added to the series. The important question, for our purposes, concerns whether changes in the *importance* of trust as a predictor of perceived risks are evident across time.

Table 6: Changes in Trust for Policy Elites Over Time⁹
(1="not at all trustworthy" 10="completely trustworthy")

	NATIONAL LABS		US DEPT OF ENERGY		ENVIRONMENTAL GROUPS	
	NM	CO	NM	CO	NM	CO
Summer '90	5.86	5.78	5.02	4.79	5.95	5.97
Winter '90	5.47	5.05	5.29	4.81	5.75	5.80
Summer '91	5.71	5.55	5.46	5.00	6.08	5.99

Tables 7 and 8 present the results of linear regression models of the effects of trust on perceived risks of transportation and permanent storage of nuclear wastes. Again, we have controlled for basic demographic attributes, along with political ideology. Table 7 indicates that that addition of the trust scores results in improvement in the models' predictive ability. Comparing the R^2 s from Tables 4 and 7, the addition of the trust scores increases the R^2 s by 77%, 38%, and 90% in the summer 1990, winter 1990-91, and summer 1991 samples, respectively. Interestingly -- and contrary to our hypothesis -- the contribution of trust as a predictor of perceptions of transportation risks seems to have been greater in the first sample than it was in the second one, though it was greatest the third sample. As expected, more trust in the national laboratories or the Department of Energy was associated with less perceived risk, and more trust in the national environmental groups was linked to greater perceived risks.

Table 7: Trust in Policy Elites and Perceptions of the Risks of Transportation of Nuclear Waste

	Summer '90 (std.coef.)	Winter '90 (std.coef.)	Summer '91 (std. coef.)
Trust DOE	0.133***	0.125***	0.158***
Trust ENV	-0.211***	-0.130***	-0.197***
Trust NLabs	0.094**	0.070*	0.185***
EDUCATION	0.060*	0.074**	0.089**
INCOME	0.072*	0.070*	0.025
AGE	0.079**	0.113***	0.076**
GENDER	-0.197***	-0.211***	-0.194***
IDEOLOGY	0.004	0.033	0.093**
STATE (1=Colorado)	-0.120***	-0.019	-0.115***
	$R^2=0.156$	$R^2=0.139$	$R^2=0.207$
Note:	* denotes statistical significance at the 0.05 level		
	** at the 0.01 level		
	*** at the 0.001 level		

Regarding perceived risks of permanent storage of nuclear wastes, much the same pattern is evident. As indicated in Table 8, inclusion of the trust variables in the three models led to increases in the R^2 s (as compared with those in Table 5) of 88%, 85% and 92%, respectively. Again, the effects of trust in these policy elites do not appear to have a monotonically increasing weight in shaping risk perceptions, as we had hypothesized. Nevertheless, as was true with transportation risks, trust did appear to have greatest weight in the third (and most recent) model. The pattern of standardized coefficients indicates that, while effects of trust in the Department of Energy and national environmental groups did not change substantially over time,

⁹ The summer, 1991 survey questions on trust contained a scale that ran from 0 ("not at all trustworthy") to 10 ("completely trustworthy"). In order to make the scores from this survey comparable to the earlier ones, this scale was recoded to have a range from 1 to 10.

the magnitude of the effects of trust in the national laboratories grew considerably over the year. This makes sense; the laboratories are probably the least well known by the public among the relevant policy elites, and the considerable press coverage regarding the labs nuclear activities over the course of the year began to allow the public to better place them in the policy context. As was true with the transportation issue, greater trust in the Department of Energy or the laboratories was associated with less perceived risk; greater trust in the national environmental groups was associated with larger perceived risks.

Table 8: Trust in Policy Elites and Perceptions of the Risks Permanent Storage of Nuclear Waste

	Summer '90 (std.coef.)	Winter '90 (std.coef.)	Summer '91 (std. coeff.)
Trust DOE	0.160***	0.144***	0.160***
Trust ENV	-0.192***	-0.158***	-0.165***
Trust LABS	0.083**	0.110***	0.182***
EDUCATION	0.068*	0.083**	0.110***
INCOME	0.054	0.048	0.053
AGE	0.089**	0.107***	0.079**
GENDER	-0.181***	-0.156***	-0.136***
IDEOLOGY	0.043	0.034	0.066*
STATE (1=Colorado)	-0.084**	-0.017	-0.104***
	R ² =0.141	R ² =0.135	R ² =0.177

Note: * denotes statistical significance at the 0.05 level
 ** at the 0.01 level
 *** at the 0.001 level

The findings regarding trust provide partial support for our hypotheses. Particularly concerning trust in the national laboratories, the importance of trust in shaping risk perceptions appears to have grown over time. Regarding trust in the Department of Energy and the environmental groups, however, trust *does not* appear to have had an increased effect over the time interval covered by our samples. In part this may reflect the fact that these organizations are generally more prominent than the laboratories, and may have been more easily identified by the respondents from exposure to other policy issues, and therefore were more readily and quickly placed into the policy context. In addition, since our time series begins in the summer of 1990, much coverage of the debate had already occurred before our first sample, allowing the more easily recognized elites to have a substantial head start toward integration into issue as perceived by the lay public.

Some clarification of the changes in the role of trust can be added by looking at the effects of trust on perceived risks in the absence of the demographic and ideology variables. Tables 9 and 10 show the results of regression models of trust on perceived risks of transportation and permanent storage, this time without controls. In absence of the ideology and demographic variables, it is clear that the decrease in R²s between summer 1990 and winter 1990-91 results from the (temporary) decline in importance of trust in environmental groups; the magnitude of the effects of trust in the Department of Energy and the national laboratories are either grow (in Table 10) or are roughly constant (in Table 9) over this period.

Table 9: A Simple Model of the Effects of Trust in Policy Elites and Perceptions of the Risks of Transportation of Nuclear Waste

	Sum. '90(std.coeff.)	Win. '90(std.coeff.)	Sum. '91 (std. coeff.)
Trust DOE	0.111***	0.110***	0.162***
Trust ENV	-0.253***	-0.161***	-0.275***
Trust LAB	0.116***	0.110***	0.219***
	R ² =0.084	R ² =0.052	R ² =0.141

In sum, our hypothesis of generally growing linkages between trust in prominent policy elites and perceived risk holds for all but the environmental groups. Given the nature of the data employed here, we cannot hope to definitively explain the temporary drop in the weight given to trust in environmental groups. However, we suspect that the onset of the Gulf War, which was initiated during the period in which the data for the winter 1990-91 sample were collected, was at least partially responsible. In the midst of national security crises like the Gulf War, critics of nuclear policies promoted by agencies of the federal government are likely to be less influential than they are in non-crisis periods. If true, the general trend toward greater weight given trust in policy elites conforms reasonably well with our hypothesis. Further and more conclusive tests, however, must await the analysis of data collected in later samples.

PERMANENT STORAGE OF NUCLEAR WASTE

(*indicates statistical significance above 0.05 level)

	Sum. '90(std.coeff.)	Win. '90(std.coeff.)	Sum. '91 (std. coeff.)
Trust DOE	0.147***	0.148***	0.164***
Trust ENV	-0.234***	-0.200***	-0.222***
Trust LAB	0.102**	0.143***	0.210***
	R ² =0.082	R ² =0.086	R ² =0.119

8. Conclusions

To summarize our findings, this analysis has shown that (a) the role of political ideology tends to have an increasing influence on risk perceptions over time, and (b) the importance of trust in prominent policy elites (with the notable exception of environmentalists during the Gulf War) in shaping risk perceptions grows over time. In contrast, (c) the influence of basic demographic attributes -- with the possible exception of education level -- appear to be relatively constant over time. While far from conclusive, these results provide substantial support for our general hypothesis that the ways in which individuals reach judgements about nuclear (and perhaps other) risks change substantially over the course of an extended policy debate. As exposure to great volumes of information about the policy dispute mounts with time, *individuals appear to become better able to integrate perceptions of risk with more conventional characteristics of policy positions, such as political ideology.* We suspect that this integrative process would hold as well for other general political constructs, such as culture or "world view" (Douglas and Wildavsky, 1982; Dake and Wildavsky, 1990). Furthermore, the increase in the importance of trust as a predictor of risk perceptions over the course of a policy debate suggests that, as with other kinds of policy disputes, individuals take "cues" from prominent policy elites regarding judgments about risk *once they are able to identify the positions of those elites within the policy context.*

We would add several important caveats. First, all of these findings must be subject to more rigorous test with a longer time series. The results shown here,

particularly with respect to the roles of trust in shaping risk perceptions, must be taken as tentative. Second, while our hypotheses have been based on an assumption of a causal direction *from* ideology and trust *to* risk perception, we expect that a complete depiction of the relationship would be bi-directional. It is quite likely that, upon comprehending an elite's policy position regarding a potential risk, that an individual will revise his or her trust in that elite. It is even possible that policy disputes over risky policies can alter aspects of an individual's fundamental ideological orientation, as when a Nevada citizen perceives the federal government to be unfairly imposing risks on an unwilling population. However, it is important to keep in mind that the more general ideological constructs take form from a wide and continuing array of sources that extend well beyond specific debates over nuclear or other technological risks, making them quite resilient.¹⁰ Thus, while acknowledging that the interaction between risk perception and more general political constructs is likely to be bi-directional, we expect that the latter will be more resistant to change, and hence will act as an increasingly important "frame" for judgments about risk as the nature of a policy issue context becomes more evident.

In conclusion, it may be a mistake to assume the existence of a uniform or constant perceptual frame through which individuals make judgments about risk. Instead, frameworks for perceptions about risk can be seen as *constructed over time* as information and feedback are supplied through vigorous policy debate. Our analysis has demonstrated that highly visible and sustained policy debates can substantially alter the contexts from which judgments about risks are made.

¹⁰ Empirical test of the interaction of ideology (or world view) and risk perception could be undertaken with panel survey data, an option which we are now exploring.

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