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ON DETERMINING PUBLIC ACCEPTABILITY OF RISK

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ABSTRACT

In recent years public opinion polls and social surveys have come to be more widely used by the media, government, and private industry to track public sentiment regarding a variety of issues. Risk analysts are simultaneously beginning to rely on such data in the tracking of attitudes and opinions bearing on the acceptability of risks. This research seeks to demonstrate how social structural analysis may be used to enhance our understanding of trends in attitudes concerning the acceptability of risk as reflected in social surveys.

When social surveys are used to track trends in public sentiment, attitudes on the acceptability of risk are often presented as univariate distributions of key indicators, such as the favorability of nuclear energy over time. However, variations in such distributions may also reflect changes in methodological approach, social structural changes, and variation in social processes. By developing a social structural model of the trend, a modicum of separation is achieved, allowing the researcher to distinguish between some methodologically induced shifts, socially-based shifts, and genuine shifts in attitudes bearing on acceptability over time. The log-linear approach used here to model these data also allows for prediction of future trends, or the prediction of acceptability of risk for different population structures. By this method we are able to interpret survey research data on the public acceptability of risk in more comprehensive and effective ways.

KEYWORDS: Perceived Risk, Acceptable Risk, Lay-Estimation, Lay-Evaluation, Social Structural Location, Social Surveys

INTRODUCTION

Survey data are widely used to track public sentiment and reported behavior regarding a variety of issues by all sectors--the media, the government at all levels, as well as private industry. In many cases risk analysts rely on such data with respect to risk in assessing the potential for public acceptability. This paper seeks to demonstrate how social structural analysis may be used to enhance our understanding of expressed attitudes reflecting the acceptability of risk. The approach allows the risk analyst to most fruitfully take advantage of large archives of existing social surveys, conduct their own dedicated surveys, or "piggy-back" some relevant questions concerning risk on existing surveys to better understand the social processes involved in lay risk assessment.

Based upon the physical requirements of nutrition, safety, and reproduction, the fundamental need for society to survive is a primary function of society.(1-4) Hence, the examination of both formal and informal mechanisms within society through which these requirements are met is nontrivial. To the extent that risk analysts are becoming sensitive to revealed social preferences for risk (5,6) or attitudes bearing on the potential acceptability of risk, an understanding of the social processes involved in the differential assessment of risk is essential. By placing these preferences and attitudes concerning risk into their social structural context, a more comprehensive understanding of their meaning is obtained.

Social scientists in general, and sociologists in particular, have typically been interested in the associations among properties, attitudes, and behavior.(7) It is precisely this perspective that addresses the various kinds of people with particular attitudes and preferences for risk. For example: Do men and women assess risk differently? If so, what seems to account for the differences? How do people with different educational backgrounds assess risk? And, if so, why? Does differential power, say in the form of resources, (7) affect risk preferences and attitudes? To the extent that people are characterized by various sociocultural and demographic properties, what is the multiple effect on their risk assessment? In short, how are differential social positions associated with risk preferences and attitudes, and indeed, with risk-related actions?

The social meaning of risk attitudes and preferences is more fully understood when the "how they are different" and the "why they are different" are addressed. Hence, the aim of this research is to address how and why risk attitudes and preferences are different among various social strata, in so far as they are, in fact, different. A social structural model of perceived and acceptable risk is developed in terms of lay-estimated risk and attitudes bearing on acceptability. It is in the context of this model that recent trends in existing social survey data are analyzed.

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This research conceptualizes risk assessment as hazard identification, involving the reduction of uncertainty through recognition; risk estimation, consisting of the measurement of risk potential; and risk evaluation, involving the determination of the social acceptability of risk.(5,6,9) Furthermore, we find no a priori reasons to believe that lay-people assess risk through significantly different conceptual processes when compared with those of experts. In fact, lay-people probably use a system of evaluation similar to that of experts, albeit less sophisticated, less rigorous, and less quantified.(10-13) The lay-system treats hazards recognition as a lay identification, of hazard, perceived risk being a lay estimation of likelihood of actualization and magnitude of effects, (14) and attitudes bearing on acceptability representing a social evaluation of risk, in which a trade-off between risk and benefits is often at least implied. The public assesses risk through a procedure that roughly parallels the system used by risk analysts. This does not imply that the results are, or even need be, similar as differences in results have been frequently reported (15,16) and thus well documented.

THE EMPIRICAL TREND

Secondary survey data concerning attitudes associated with nuclear energy are available. Public opinion polling agents have frequently assessed such attitudes and much of the data has been made available to researchers.(17) Among these data are regional, national, and local surveys. Spanning just slightly more than four years, the Louis Harris and Associates (18, 19-22) surveys analyzed here were conducted in an important period in the development of nuclear power as a source of electric energy. Several events in the 1975 to 1979 period were significant, including the Browns Ferry fire; several state referenda to ban nuclear development; and perhaps most significant, the Three Mile Island incident. The surveys conducted in March 1975 and July 1976 involved face-to-face interviews concerning the many salient issues associated with nuclear power, including: the perceptions of the seriousness and meaning of the energy crisis, alternative methods of meeting future demand for energy, and attitudes about nuclear power, its development, and safety. The survey, conducted in April 1977, consisted of personal interviews addressing more typical issues of public opinion, economic and political interest, energy conservation, and safety. While the March and April 1979 surveys once again focused more succinctly upon issues associated with energy and nuclear power, the former was a face-to-face interview and the latter was conducted by telephone.[1] The 1975 and 1976 Harris surveys are household samples of the entire continental United States. They are limited to adults 18 years of age and over and to the non-institutionalized population. "Scientifically random sampling techniques guaranteed to each household in the country an equal chance of being drawn into the sample."(19:p.vii) Based on the Harris approach to sampling, (23) we presume that a stratified multistage

cluster sample of about 100 primary sampling units (PSUs) was used with random selection within these PSUs. The PSUs are drawn with probabilities proportional to population size, and random sampling within PSUs assures the overall equal probability of household selection. While no specific sampling information is available for the April 1977 and March 1979 surveys, these procedures appear to have remained unchanged. (That is, the procedures used in the 1975 and 1976 surveys were also utilized in April 1977 and March 1979.) The April 1979 survey, being a telephone interview, requires special mention. There is no specific sampling information, but Harris telephone procedures are of the random-digit-dialing variety, (24) and thus assure the inclusion of both unlisted and non-listed telephones.(25) The sample size of 1,200 is consistent with a ± three percent sampling error at the 95 percent confidence level.

Lay risk assessment rests on the foundation of evaluation and estimation of risk for identified hazards, because unrecognized risks cannot be estimated or evaluated. Furthermore, since evaluation and estimation cannot be measured directly, they must be cast in terms of their components or elements. In the case of nuclear power, the risks have been recognized for some time. Thus, indicators of social evaluation and risk estimation are sought for the general public. In each of the Harris surveys, respondents were asked to assess their general attitudes concerning building more nuclear power plants in terms of being favorably disposed or not. In addition, respondents were asked, in each survey, to evaluate nuclear power plant safety. The favorability associated with building nuclear power plants may be viewed as bearing on potential acceptability, while perceived safety reflects a lay estimate of risk.

The distribution of responses concerning favorability associated with nuclear power across these five surveys (Table I) indicates continued support for nuclear power in general terms (i.e., there are more favorable responses than any other in each survey). However, this support erodes from 63.4 percent favoring nuclear power in March 1975 to a low of 44.5 percent immediately following the Three Mile Island accident in March 1979. Secondly, the opposition response more than doubles over the period from 18.7 percent in March 1975 to 43.6 percent in April 1979. Finally, the percentage of people remaining unsure is reduced from 17.9 percent in March 1975 to 6.9 percent in April 1979. As the primary shifts in these responses occur between April 1977 and March 1979, long after other significant events, but more in the immediate aftermath of the Three Mile Island incident, the shift in attitudes concerning nuclear power appears to be attributable to TMI and its aftereffects. For example, the Browns Ferry fire and the public debate surrounding the various State referenda concerning nuclear energy would have been expected to yield attitude shifts reflected in the April 1977 data; however, this does not occur. Based on this, it is tempting to speculate that the erosion of support for nuclear energy comprises people shifting to opposition responses from

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TABLE I. PUBLIC ATTITUDES ABOUT BUILDING NUCLEAR POWER PLANTS IN UNITED STATES 1975-1979

Louis Harris and Associates:

In general, do you favor or oppose the building of more nuclear power plants in the United States?

Survey Date:	N	Responses		
		Favor	Oppose	Not Sure*
March 1975	1537	63.4%	18.7%	17.9%
July 1976	1497	60.8%	22.3%	16.9%
April 1977	1547	60.4%	23.9%	15.7%
March 1979	1510	44.5%	42.1%	13.4%
April 1979**	1200	49.5%	43.6%	6.9%

*A small proportion of the not sure response is comprised of don't know, no answer and non-response missing data codes.

**The April 1979 survey was conducted by telephone.

both favorable and unsure responses because of TMI. The explanation for such a shift might be that the accident and its aftermath served to increase the lay estimated risk and thereby induced such a shift in attitudes. However, the data regarding perceived safety (Table II) are to some extent inconsistent with this decision. First, the percent finding nuclear power very safe declines only modestly, from a high of 25.8 percent in March 1975 to a low of 20.7 percent immediately following the accident in March 1979. Second, the proportion reporting nuclear power as not safe (or dangerous in 1975 and 1976) increased from a low of 18.1 percent in March 1975 to a high of 28.8 percent in April 1979. This shift is significantly smaller than the magnitude of shifts found in opposition to nuclear power. The proportion of people finding nuclear power somewhat safe increased from 35.8 percent in March 1975 to 46.1 percent in April 1979 reflecting growing ambivalence. Finally, and perhaps most significantly, the proportion of people remaining unsure is reduced dramatically, from 20.3 percent in March 1975 to 2.3 percent by April 1979. This seems to indicate that the Three Mile Island accident served primarily to help people decide (perhaps only temporarily) about nuclear energy. To those people who found nuclear power plants relatively safe, the accident, or the lack thereof, proved just how effective the safety systems associated with nuclear power plants can be. For people who were apprehensive about the safety of nuclear energy, the accident served to confirm the risky nature of nuclear energy production systems.

TABLE II. PUBLIC PERCEPTION OF NUCLEAR POWER PLANT SAFETY 1975-1979

Louis Harris and Associates:

All in all, from what you have heard or read, how safe do you think nuclear power plants that produce electric power are--very safe, somewhat safe, or not safe?

Survey Date:	N	Responses			
		Very Safe	Somewhat Safe	Not Safe*	Not Sure**
March 1975	1537	25.8%	35.8%	18.1%	20.3%
July 1976	1497	25.4%	38.3%	23.3%	13.0%
April 1977	1547	28.7%	36.7%	23.0%	11.6%
March 1979	1510	20.7%	47.8%	27.0%	4.5%
April 1979	1200	22.8%	46.1%	28.8%	2.3%

*The 1975, 1976 and 1977 surveys allowed a voluntary "dangerous" response, however, in both 1979 surveys this response category was not allowed. The "dangerous" responses are collapsed with the "not safe" response in this analysis.

**A small proportion of the not sure response is comprised of don't know, no answer and other non-response codes.

The historical effect associated with the Three Mile Island accident and its aftermath is only one of several potential sources of attitude change. First, changes and modifications in survey instruments themselves can result in apparent attitude shifts. Furthermore, if the sampling or survey methods employed changed, apparent attitude shifts might also result. This would include question wording, question placement, interviewer instruction, and mode of data acquisition (e.g., face-to-face, telephone, and the like). Certainly, the variety of question contexts in this analysis and the shift to a telephone interview in the April 1979 survey are among the critical considerations for the interpretation of the observed shifts in attitudes. Some of the trends presented in Tables I and II are sufficiently small so that sampling error alone might account for most or all of the apparent changes. Second, changes in the social processes that guide our behavior and attitudes may acount for the attitude shift. For example, the apparent shift in support for nuclear power plants might be concomitant with a more fundamental shift away from technology and tech-

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nological solutions.(26) In essence, the norms that determine what is acceptable may change, which would induce change in specific risks as well. Third, changes in demographic character can significantly alter attitudes, particularly those concerning risk. This arises because of the distribution of various risks among geographic locations, age groups, and the sexes. Recent population trends such as the growing number of Hispanics in the United States and the in-migration to Southern and Western states (Snowbelt to Sunbelt) may affect attitudes about specific risks through differential values and altered saliency. Nuclear power plants are currently concentrated more in the Northeastern United States than elsewhere. Hence, large outflows of population to Southern and Western States may make nuclear energy both less needed and desirable, as greater proportions of people come to rely on alternative sources of electrical energy such as coal, hydro-electric power and solar power. Finally, because people are associated with various groups and organizations in society, and each of these associations is characterized by a role, which, in turn, is guided by some norms quite specific to the organization's needs, attitudes are likely to vary among social strata. The value systems created by these various role sets form the foundation for assessing attitudes concerning acceptable risk. The social evaluation of risk rests comfortably within the domain of such values.

The social structural analysis discussed in this paper examines attitudes concerning perceived and acceptable risk in terms of some aspects of social structural location. That is, there are groups or classes of people that estimate and evaluate the risks associated with nuclear power plants similarly. The social structural approach used herein draws both on the social theories of stratification and the risk assessment process, by explicitly (wherever possible) including both social structural elements and attitudes reflecting risk assessment.

SOCIAL STRUCTURAL LOCATION

Human societies are marked by inequality in the sense of access to, and distribution of, scarce resources. Since risk may be thought of as "negative resources" or, conversely, protection (safety) as goods and services, it follows that risk is also likely to be unequally distributed. Whether stratification is functionally necessary (27-29) or simply universally observed (30-33), people within various strata maintain different values, beliefs, attitudes, and opinions. Attitudes concerning risk are also expected to mirror some of these important differences.

The concept of social structural location includes elements of vertical and horizontal status and the associated roles, norms,

values, and experiences. The social structure comprises a web of relationships among roles or positions in the social system.(8,34-36) Patterns of association among positions reflect status clusters, which are characterized by frequent in-group relations and less frequent between-group relations.(36,37) Describing these status clusters by their multivariant status indicators, the primary status clusters are examined. While hierarchical ranking among status clusters is termed stratification, social structural location reflects explicitly both the horizontal and vertical dimensions of stratification. Further, it is static, frozen in time, and as such does not reflect a change of role or position in the social structure in the form of social mobility. Social structural location has elements of both horizontal and vertical stratification as reflected in a static position in the social structure. Further, it is conceptually broader in that it is more closely associated with the patterned web of relationships in the social structure and reflects differential values, norms, roles, and experience.

A Louis Harris and Associates survey (24) conducted from December 1979 to March 1980, finds that women, the elderly, and ethnic minorities are more sensitive to risks "associated with living today" than are their counterparts. Hence, differential risk sensitivity is associated with various strata or positions in the social structure, and people in the social structure view risk and potentially risky situations differently. Simultaneously, risks are not distributed equally. For example, older people may be more susceptible to some types of risk than other adults, while some risks affect only the very young or predominantly women. Because risks are not equally distributed, death rates are nearly always adjusted by age and sex. Furthermore, research concerning the generation of electricity in nuclear power plants (17,38,39) indicates that individuals differ with respect to their attitudes at least in terms of acceptability of the risk associated with nuclear power.

This variation is associated with a variety of indicators of structural location (status), including sex, education, income, occupation, and age. When Brody (40) re-examined the data from two Harris surveys (18,19), he posited that women find nuclear power plants less acceptable than men because they maintain different values with respect to technology, the value of life and future generations, and the risks associated with nuclear power facilities. It was not argued so much that women know less about technology (although this was considered a modest factor), but rather that a different value system is employed in the social evaluation of risk due to the more marginal location of women in the social structure (at least historically so). Because men are more "centrally" located in "economic, political, and technical spheres," they will recognize more of the associated benefits of nuclear power and, hence, be more likely to support continued development of nuclear energy, despite such risks as they may themselves perceive. Women, on the other hand, "are either

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excluded or occupy less central ('marginal') positions in these spheres" (40:p.14) and are thus less likely to recognize the benefits of nuclear energy, so that "risks", in a way, "loom larger."

Perceived risk, in terms of estimated likelihood of nuclear power plant accidents or of nuclear war, has been shown to be associated with structural location in terms of education, age, and sex.(11,12) The association of age with estimated risk is most consistent, and particularly so among young adults (18 to 29 years of age). Young people tend to consistently estimate risks at higher levels than middle-aged (30 to 49 years of age) or older Americans. Previous work (12) suggests that this effect is due to differing roles and values at various age groups rather than effects associated with growing older (age cohort rather than simply maturation effect).

Finally, social structural location plays an integral role in determining response to realized hazards.(41-50) The fundamental position is that because of the conflicting loyalties associated with a complex stratification system in a complex industrial and urban society, response to realized hazard, say in the form of disaster, is a function of social identification and social structural location. In essence, who the social actor is in terms of social identification, and what responsibilities are associated with that particular role, determine to a large extent the nature of disaster response. For example, an adult in a household with children (a parent) will be more likely to take adaptive action in the form of relocation than a non-parent.(51)

MEASUREMENT

This research develops a simple model of social structural location, in terms of descriptive characteristics, using both perceived risk in terms of lay-estimated likelihood and perceived safety, and acceptability of risks associated with nuclear power plants, in terms of favorable and non-favorable attitudes. Descriptive characteristics of social structural location include indicators of both achieved and ascribed status. The status indicators of age, sex, and education are considered in this research due to:

- Their prominence in the status literature, (35-37, 52-57)
- The unequal distribution of risks among people as demonstrated by age and sex adjusted life tables,
- Their relatively consistent relationship to views regarding nuclear power, (17, 38, 39, 40) and the reported associations with risk sensitivity, (24)

- Their role in determining response to an actualized risk in the form of disaster.(41, 44, 59)

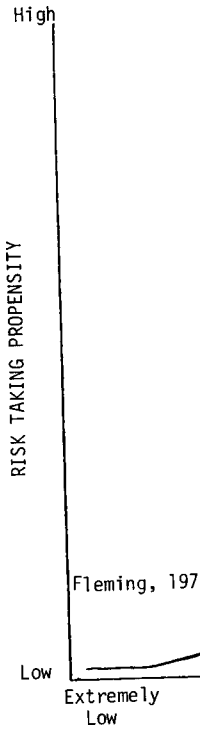
Hence, the social structural characteristics of age, sex, and education are selected not only because they reflect differing social experience (7) but also because they have been shown to be associated with differential beliefs, attitudes, and behaviors regarding risks of various kinds--and, in particular, nuclear risks.

The effect of age in determining the acceptability of nuclear risks (17) and risk in general, (24) has been reasonably well documented. In addition, the effect of age seems to be predominantly a function of differential value maintenance, (12) perhaps associated with the roles that are typically being played by persons in various age groups, or the flows of generations in terms of "critical experience." Hence, these differential value systems produce patterned variation in the estimation of likelihood associated with various risks. The consistent propensity for young adults to estimate the likelihood of nuclear war as "likely" or "very likely" is primarily a function of the values associated with a position in life which may be thought of as a product of the roles associated with that position, as opposed to the experience of growing older through the aging process. Three categories of age are used throughout this research: young adults--those 18 to 29 years of age; middle-aged adults--those 30 to 49 years of age; and older Americans--those 50 years of age or older. These three categories of age are thought to represent the differential roles associated with position in life better than alternative age groupings.

Education is related to nuclear power attitudes (17) with more than compulsory education (High School) being associated with a tendency to favor the technology. One explanation suggests that enhanced knowledge associated with higher than compulsory levels of education tends to reduce perceived risk which, in turn, makes nuclear power plants more acceptable. Another explanation suggests that higher education is associated with higher social status, which, on the one hand, reflects greater personal resources which can be relied upon in the event the risk is actualized, and, on the other, may reflect an underlying propensity to take risk. The latter effect reflects the observed association between risk taking, say in the form of innovative behavior, and social status.(61-66) Figure 1 summarizes this relationship.

PERCEIVED SAFETY AND FAVORABILITY

This analysis examines the association between perceived nuclear power plant "safety" and "favorability" associated with nuclear technology in terms of the age, education, and sex indicators of social



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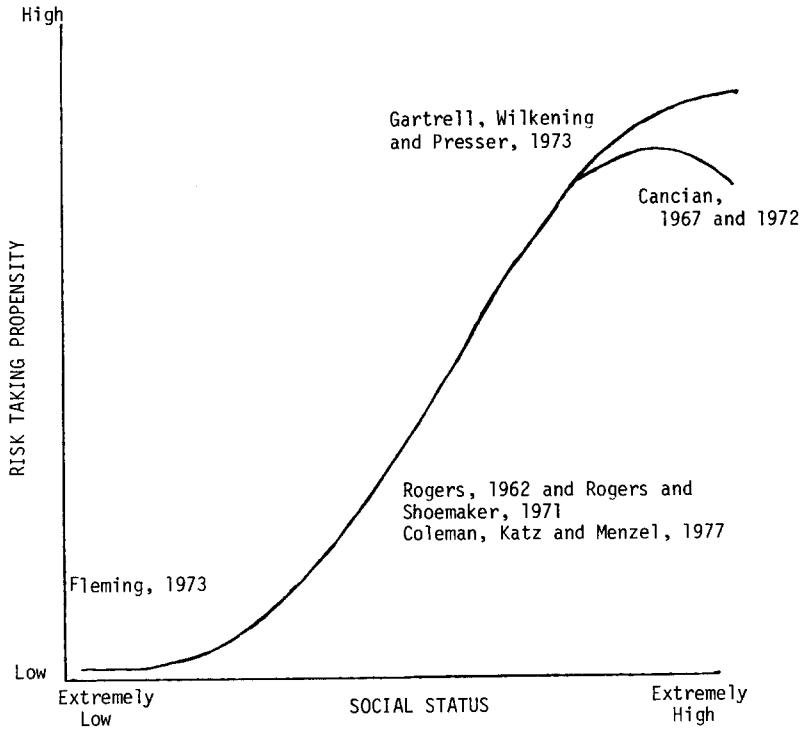

Figure 1. A Suggested Curvilinear Relationship Between Social Status and Propensities to Take Risks

structural location. It is undertaken in terms of contingency table analysis using log-linear techniques.(67-70) This analytic technique is appropriate for cross-classified or contingency data. It essentially searches for a set of subtables that account for systematically patterned variation in contingency tables once "fitted" in accordance with an underlying conceptual model. This technique allows the researcher to systematically account for variation in the contingency tables and isolate specific associations in the context of the model.[2] A parsimonious model fits the data in the Harris surveys with probabilities of Type I error of .107 and explains nearly 93 percent of the variation in the table. The subtables in the model are represented as {FS} {FX} {FY} {SE} {SA} {SX} {SY} {EA} {EY} {FA} {AX} and {AY}, where F represents favorability, S safety, E education, A age, X sex, and Y year of the survey. Notice that the AX and AY terms reflect a slightly disproportionate distribution of females in the 30 to 49 years of age grouping. The latter effect could be viewed as a model adjustment which accounts for the use of telephone survey methodology

in the April 1979 survey, which would be more likely to produce female respondents in the middle age group.

The resulting (best fitting) model includes only two factor terms. Hence, the majority of the variation in the five survey contingency table is accounted for (i.e., R^2 analogs greater than .92) with a two factor model. The log-linear effects for this model are presented in Table III. The most important association in the data, and, hence, in the model, is the association between the favorability associated with "building more nuclear power plants in the United States" and perceived safety associated with nuclear power plant operation. Respondents finding nuclear power plants "very safe" are nearly three times more likely to favor building more plants than would otherwise be expected. Conversely, respondents perceiving the operation of nuclear power plants as "not safe" are less than one-half as likely to favor building nuclear power plants. In the sense that the standardized values are quite large in this analysis, the association between perceived safety and favorableness is a very robust relationship.

TABLE III

DIRECT AND MARGINAL LOG-LINEAR EFFECTS (λ) ON FAVORABILITY ASSOCIATED WITH "BUILDING NUCLEAR POWER PLANTS IN THE UNITED STATES" AND PERCEIVED SAFETY

	Marginal	Very Safe	Somewhat Safe	Not Safe	Favor
Marginal	2.22	-.158	.913	.119	.063
Favor	--	1.08	.207	-.845	--
More than High School Education	-.258	.261	.037*	.003*	NA
Age 18 to 29 years	-.141	-.138	.142	.050*	-.091
Age 50 or more years	.065*	.027*	-.193	-.037*	.077
Males	-.036*	.323	-.012*	-.084	.118
March 1975 Survey	.144	-.197	-.235	-.245	.202
July 1976 Survey	.142	-.197	-.212	-.014*	.158
April 1977 Sruvey	.145	-.018*	-.206	-.050*	.098
April** 1979 Survey	.382	.258	.349	.272	-.171

*Not significant at .05 level comparing standardized linear value and students. NA indicates that the effect is not estimated as it is not part of the model.

**April 1979 Survey was conducted by telephone.

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.207	-.845	--
.037*	.003*	NA
.142	.050*	-.091
-.193	-.037*	.077
-.012*	-.084	.118
-.235	-.245	.202
-.212	-.014*	.158
-.206	-.050*	.098
.349	.272	-.171

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The most important social structural component is the simultaneous effect being male or being female has on both perceived safety and associated favorability. Females[3] are nearly 12 percent less likely to "favor" nuclear technology and simultaneously more than 30 percent less likely to find nuclear power plant operation "very safe",and around 8 percent more likely to judge it "not safe" when compared to males. In addition, women are about 23 percent more likely to remain "unsure" with regard to nuclear power plant safety than their male counterparts. Hence, this analysis is consistent with both the findings of Melber et al. (17) and Brody.(40) Previous analysis of these data (12) indicated that females were over 40 percent less likely to judge nuclear power plants "very safe," approximately 15 percent more likely to find them "not safe," and about 25 percent more likely to remain "not sure" when only perceived safety is considered. Hence, the substantial proportion of the association between perceived safety and sex is accounted for when nuclear power plant favorability is introduced into the analysis. This reflects the added interpretive value we get by modeling the social structural characteristics and the risk assessment attitudes simultaneously.

As previously mentioned, age and favorability are significantly associated in the model, with young adults being about nine percent less likely to favor building more nuclear power plants than other age groups. Young adults are less likely to find nuclear power plants "very safe" than would otherwise be expected. They are about 14 percent more likely to find nuclear power "somewhat safe." In addition, four Harris surveys (18, 19, 21, 22) were employed in an analysis of only perceived safety, which suggests a different model and data structure, and in that analysis also, young adults are 14 percent more likely to find nuclear power "somewhat safe" than would be expected otherwise.(12) Comparisons between the four survey model (without favorability) and the five survey model (with favorability) reflect remarkably consistent associations between age groups and perceived safety response. These consistent results point to a tendency among young adults to be somewhat apprehensive about nuclear power plant safety. Adults aged 30-49 years tend to be more or less neutral regarding nuclear power plant safety. This tendency is reflected in the fact that in these models, the association for middle age group is not significant at the .05 level for any category of perceived safety.

Also reflected in the reciprocal association is the finding that adults 30-49 years of age are less "unsure" than other age groups, when nuclear power plant safety is considered. Adults in the middle age category are simultaneously more likely to have made a decision concerning nuclear power plant safety, and are more or less equally distributed among the other categories. Hence, their neutrality is not just a lack of decision or ignoring of the issues in an indifferent sense, but rather reflects a decisive neutrality among the respondents of the middle age group.

Older Americans (age 50 years or more) are simultaneously less likely to find nuclear power "somewhat safe," which is also found in the four survey model, (12) and more likely to remain "unsure" regarding nuclear power plant safety. These findings are consistent with regard to the model employed and may reflect a certain indifference, perhaps in the sense of an inability to decide about complex technological systems. However, having made a decision, older adults are less likely to choose the least committed "somewhat safe" response, indicating a "polar" response tendency among older Americans.

While education is not significantly associated with attitudes concerning acceptability of nuclear power in terms of favorableness (even enough to be included in the model), education is significantly associated with perceived safety. Respondents having completed more than a high school education are consistently less likely to make an "unsure" response, and at the same time, more likely to respond that nuclear power plant operations are "very safe." The effects are remarkably consistent across the three survey model of community and United States favorability reported by Rogers (13) where three surveys were used and the current five survey model, as well as the four survey model where favorability is not considered and income is introduced.

Viewing Rogers' (12) four survey model as an elaboration of the present model with regard to the association between education and perceived safety, income and education are confirmed as having independent effects. Given that education and income are strongly associated, this suggests an important differential role being highlighted by the two status indicators. Higher income presumably reflects a propensity to take risks and enhanced resources with which to deal with any consequences of actualized risks, and the reverse descripton may apply to the lower income groups.(71) Education, on the other hand, presumably reflects a "knowledge base," which is also reflected in the particularly robust association between education and the "not sure" response in the model.

The historical trend, reflected in the models, with regard to the perceived safety and favorability associated with "building nuclear facilities in the United States" is best examined in this context. This is true for the most part because variations associated with changes in the empirical distributions for any given model characteristic (e.g., age, sex, or education) are accounted for in the model. Hence, the log-linear effects for "favorability and year of survey" in the model decrease from .202 in the March 1975 survey to -.171 in the April 1979, indicating that holding age, sex, education, and perceived safety constant, respondents were much less likely to favor nuclear power in March of 1979 than in March of 1975.

Furthermore, by examining the intervening survey effects and the historical events of the period, it is recognized that this shift does

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not appear to be associated with the fire at Browns Ferry or its aftermath (72) or the state referenda of 1976 (19, 40) in California, Colorado, Arizona, Montana, Oregon, Washington, and Ohio.[4] The shift is most pronounced as a by-product of the most visible event of the period, the nuclear power plant accident of March 1979 at Three Mile Island (TMI) and its aftermath.(21, 22, 48-50, 73) While the duration of these rather dramatic shifts, in terms of how lasting the effect might be, is not clear from these data, it may be suggested that the impact of TMI has been primarily to solidify opposition and support and reduce the number of people holding no opinion or remaining undecided.

Accounting for any variation associated with the structural components of the model--age, education, or sex--and the risk estimation component, perceived safety in the favorability of nuclear power plants allows the risk analyst to isolate the effect associated with the intervening social/historical event, such as TMI. Table IV presents the odds ratios for the proportion favoring nuclear energy to all other responses, and the odds ratios for finding nuclear power plants somewhat to very safe. While the adjusted ratios are a direct consequence of the model, the adjusted ratios reflect the expected historical trend after accounting for the effects of age, sex, and education. Hence, any shifts in survey or sampling techniques which might be accounted for by any or all of these social structural components are accounted for by the model. Support for nuclear power, as reflected in the adjusted ratios, is highest in 1975 at 1.699 favorable response per those not favoring. In the March 1979 survey, immediately following TMI, the adjusted ratio is lowest at .640. This adjusted ratio is considerably lower than the observed ratio, which

TABLE IV

OBSERVED AND ADJUSTED RATIOS FOR FAVORING BUILDING NUCLEAR POWER PLANTS IN THE UNITED STATES TO ALL OTHER RESPONSES AND FINDING NUCLEAR POWER PLANTS SOMEWHAT SAFE TO VERY SAFE--MARCH 1975 TO APRIL 1979

	Favor/Non Favor		Somewhat/Very Safe	
	Observed	Adjusted	Observed	Adjusted
March 1975	1.732	1.699	1.388	2.810
July 1976	1.551	1.556	1.508	2.875
April 1977	1.525	1.380	1.279	2.418
March 1979	.802	.640	2.309	3.397
April 1979	.980	.806	2.022	3.197

tends to reflect the importance of the conceptual model of the trend that includes theoretically important factors, both concerning risk and the social structure. Furthermore, the adjusted ratio fails to recover in the April 1979 survey to a nearly one to one ratio as the observed ratio does, which also reflects the added statistical control associated with the approach. The smoother trend represented by the adjusted ratio points out the potential pitfalls of using unadjusted, uncontrolled surveys. While this research adjusts for the social characteristics of age, sex, and education, and the risk factor, perceived safety, other social structural and risk factors may also be needed to adequately adjust such data for use in the evaluation of risk in terms of acceptability.

Perceived safety may be compared across surveys in a similar manner. This examination shows that for the current model of favorability, and particularly for the "Community" favorability, (13) respondents were 25.8 percent more likely to find nuclear power plants "very safe" in March of 1979 than otherwise expected. Simultaneously, respondents were approximately 34 percent more likely to find nuclear power "somewhat safe" in 1979 than otherwise expected, while the variation in the period for the "not safe" category was only marginally significant, with only the March 1975 and April 1979 surveys being significantly associated with the "not safe" response. This is a slightly different pattern than is observed for the four survey model where favorability is not considered. While the primary shifts associated with the "somewhat safe" and "not sure" categories remain very similar, the shifts in the "not sure" category are substantially reduced and a shift is substantially introduced into the "very safe" responses. Hence, we conclude that by elaborating the data in terms of acceptability, a confirmatory role of the TMI incident is illustrated. That is, among those who favor nuclear power, TMI was interpreted as confirming its safety; while among those who do not favor nuclear power, TMI served to underscore the lack of safety in nuclear power plant operation.

Isolating perceived safety by accounting for the social structural characteristics and the acceptability associated with nuclear power demonstrates the utility of the modeling approach. Not only do the observed ratios change with the adjustment, but even the overall pattern is altered. In every survey, except the April 1977 survey, the ratio is near the three to one mark. The observed ratios never exceed 2.309 to one and go as low as 1.388 to one in March 1975. Hence, by modeling the five survey trends, we find that the ambivalence associated with responding that nuclear power plants are somewhat safe is accentuated. While it is highest immediately following TMI and lowest in the April 1977 survey (in both observed and adjusted ratios), the adjusted ratios are considerably higher. Furthermore, because the difference between observed and adjusted ratios is more pronounced in the somewhat to very safe ratio than in the favor to not favor ratio, most prominent causal direction between

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lay-estimated risk and lay-evaluated risk is illuminated. That is, while perceived risk affects the manner in which risk is evaluated, it appears, from this research, that the degree of acceptability affects the estimation of risk even more. Hence, the prominent causal direction is from lay-evaluated to lay-estimated risk, rather than the other way around.

CONCLUSION

As the trends in survey data are used by risk analysts and policymakers to guide public policy concerning risk, our approach must reflect accurately our best understanding of the problem. It cannot be limited to merely technical aspects of the risk any more than such decisions can be based on purely social considerations. In order for the risk analyst to appropriately utilize public opinion data in determining the potential for acceptability of any given risk, they must first begin to understand the social processes involved in lay risk assessment. If policies concerning risk are to appropriately reflect the value system in which they rest, we must incorporate these values and the people that hold them into the information base that guides these policies. This research takes a first step in this direction by analyzing risk attitudes in terms of social structural location in order to gain insight into the processes involved in lay risk asessment.

Substantively this analysis seems to support the marginal location explanation for differential risk attitudes in terms of perceived and acceptable risk. Women, the less educated, and particularly young adults (but to some extent older Americans) tend to estimate risk at higher levels and be less likely to find, at least nuclear, risks acceptable. This analysis not only confirms Brody's (40) explanation for women's attitudes concerning nuclear power, it expands the explanation to other marginal positions of the social structure. This analysis is consistent with the posited explanation that marginal locations in social, economic, political, and scientific spheres will be likely to have lower perceived self-efficacy and be less likely to occupy key or powerful positions than more central locations. Hence, individuals occupying marginal locations are less likely to find the risks associated with nuclear energy acceptable and more likely to estimate those risks at higher levels than more central positions.

This research seems to confirm that lay people use a similar risk assessment process to that of experts, although perhaps with less sophistication and rigor, and certainly with differing results.(13) Lay people tend to treat risk estimation, in the form of perceived safety, and risk evaluation, in the form of favorability, independently, and simultaneously as related. Furthermore, this research suggests that while perceived safety affects favorability, the prominent causal relation is in terms of how potential acceptability shapes the

perception of risk. It is almost as if the predominant question is "whether the risks are worth taking," as opposed to "how risky they may be." Hence, for lay people the conceptual process consists of hazard recognition, risk estimation, and social evaluation, just as for risk analysts. For lay people, however, the emphasis rests on acceptability and how that bears on social evaluation, while risk analysts place greater emphasis on estimation of risk and occasionally upon identification. This social structural approach to determining the acceptability of risk places greater emphasis on the value system and how its differential nature across the social system affects risk assessment. By doing so, we not only gain insight into the social processes affecting the way risk is assessed, but we also enhance our ability to determine the potential for acceptability across various risks and among people with different value systems.

FOOTNOTES

1. Harris survey data provided through the courtesy of Louis Harris Data Center, University of North Carolina, Chapel Hill.
2. Actual analysis was conducted using BMDP Biomedical Computer Program: P-series software package, specifically program P3F.
3. The female association with favorability is the reciprocal of the male association with favorability presented in Table III.
4. All of which were defeated, as reported in the November 11, 1976 issue of Nucleonics Week.

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