The Social Fabric and Innovation Diffusion: Symbolic Adoption of Food Irradiation

Stephen G. Sapp
Peter F. Korsching

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Abstract

This study used a longitudinal, panel design to examine the effects of negative information acquisition, compliance with opinion leader endorsements, and social demographic characteristics on consumers' symbolic adoption of food irradiation. Data collection coincided with the first market test of irradiated food conducted by a commercial firm, which took place in Minneapolis, Minnesota in 2000. Approximately half the subjects (n = 116) received a packet containing information from proponents and opponents of food irradiation. The remaining subjects (n = 107) were provided with no information about the technology. The results indicated that, initially, negative information acquisition, even when accompanied by positive endorsements from opinion leaders, decreased symbolic adoption. Over time, however, this negative effect was mitigated by compliance with endorsements from opinion leaders. The results suggest that confidence in social institutions might be a determinant as well as an outcome of adoption decisions. Implications are suggested for risk communication strategies regarding controversial agricultural technologies.

Introduction

Recent advances in the life sciences have introduced the public to complex new food production and processing technologies. In some cases, citizens express little concern about new technologies. On the other hand, public discourse about the efficacy and ethics of and social equity issues associated with genetically modified foods, irradiated food, and the cloning of animals, to name some contemporary innovations, has become contentious as proponents and opponents clash over the potential benefits and costs of these new practices. One question to be raised in observing public controversies about new food-related technologies is: What is at stake for society in these deliberations?

Always at stake is *citizens making the right choice*; that is, selecting technologies with significant relative advantages that also appeal to public perceptions of social equity and sense of morality. Of course, consensus rarely exists on the criteria for addressing these issues, and decisions to adopt can never be classified unambiguously as correct given that all technologies inherently are flawed in some respects and have negative consequences for some segments of the population (Freudenburg 1988; Rogers 1995; Slovic 2000). Additionally, pressure always exists on citizens to make decisions *as quickly as possible* so that society can benefit from economic comparative advantages and people in need can receive help--under the presumption that the technology is mainly beneficial--or avoid widespread negative consequences--under the presumption that the technology is mainly harmful.

Also at stake for societies might be the *quality of the social fabric* within which consumers make their adoption decisions. Short (1984) pointed out, as have others since (e.g., Freudenburg 1993; Krannich and Smith 1998; Luloff and Swanson 1995; Rosa and Clark 1999; Short 1999;

Slovic 1999), that despite the many advances made in the quality of technical risk assessments, public confidence in them has eroded because people are forced to place more and more trust in social institutions that sometimes seem incapable of properly managing technology. Changes in agricultural production and processing (e.g., fewer farms, large-scale animal feeding operations, cloning, genetic modification, irradiation) have left consumers, for example, far removed geographically and conceptually from their food and susceptible to skepticism about whether the food system is properly regulated (Tomazic, Katz, and Harris 2002). What also might be at stake, therefore, is a *sense of confidence in the social institutions* upon which democratic societies depend (Freudenburg 1993). Thus, social scientists interested in the quality of the social fabric as an *outcome* of public discourse about technology examine public decision-making within the context of relationships among science, technology, and society (e.g., Beck 1992); the political economy of technology development and dissemination (e.g., Busch 2000); and community-level responses (e.g., Luloff, Albrecht, and Bourke 1998) to understand how technology decisions can affect social structure and the quality of the social fabric.

Social scientists also examine citizen decision-making processes about controversial technologies. Central to these studies have been investigations of the effects of positive and negative information acquisition on consumer opinions. Because negative information significantly affects opinions (e.g., Siegrist and Cvetkovich 2001) and becomes known to the public primarily through mass media presentations (e.g., Ten Eyck 1998), some (Slovic 1999: 689) argue that the "risk assessment battlefield" is the medium of mass media presentations. That is, whoever controls the language of risk on this battlefield controls also the tone and outcome of public debate about complex technologies (see also: Beck 1992). From this perspective, strategies for gaining adoption/rejection of new technologies should focus upon information dissemination, control over the media, and managing the language of risk used to describe the innovation.

Although recognizing the importance of information dissemination on public risk assessments, other lines of inquiry (Rogers 1995) argue that public confidence in social institutions might be equally or more important than information content (i.e., especially technical content) in influencing socially constructed technology decisions. The diffusion of innovations model, for example, asserts that consumer skepticism arising from negative information acquisition can be mitigated by endorsements from trusted sources viewed as having no significant vested interest in the adoption or rejection of the new technology (Rogers 1995). These *opinion leaders* are posited as having the ability, through their endorsements or lack thereof, to sway public decisions because their prestige based upon earned respect gives them much social influence within the collectivity (Burt 1999; Valente and Davis 1999). As respected referent others, opinion leaders can be either individuals or organizations located either locally or within a broader social collectivity. Innovation diffusion thereby entails a two-step process: information delivery, typically through mass media outlets, and social persuasion through endorsements from opinion leaders.

Thus, a key question to be asked in understanding public risk assessments is: What are the relative effects of the *social* influence of positions taken by opinion leaders and the *cognitive* influence of information messages on evaluations of controversial technologies? That is, is the landscape of the risk assessment battlefield restricted mainly to the mass media, wherein the rules of engagement are to control the language of risk, or do mass media presentations represent just the opening skirmish for a broader scope of battle that includes also gaining endorsements from opinion leaders? If the latter is a more accurate depiction, then risk communication practice should perhaps place less emphasis upon managing information flow and more emphasis upon facilitating effective relationships between citizens and the social institutions that can act as opinion leaders.

In summary, public controversy about new agricultural technologies is driven in part by the nature of consumers' socially constructed assessments of information received by proponents and opponents. Psychometric studies have gathered substantial evidence to support the proposition that consumer opinions are strongly affected by hearing negative information about a technology (e.g., Siegrist and Cvetkovich 2000; Slovic, 1999), an effect that might occur because negative information is considered either more diagnostic (e.g., Skowronski and Carlston 1989) or credible (Siegrist and Cvetkovich 2001), or because people want to avoid losses (Highhouse and Paese 1996). The diffusion of innovations model, in contrast, posits that endorsements from opinion leaders will be sufficient to offset initial consumer skepticism. Consumer confidence in social institutions that serve as opinion leaders, therefore, might act as a critical determinant of their decision-making about controversial technologies. Thus, if social institutions entrusted with regulating the food system can act as opinion leaders for public opinions about controversial agricultural innovations, then confidence in social institutions might be a *determinant* as well as an outcome of public decision-making about these innovations (e.g., Freudenburg 1993; Rosa and Clark 1999; Short 1984, 1999). Brown (1981), for example, posits that social institutions represent not only a level of development resulting from the diffusion process, but also facilitate the diffusion process.

Unfortunately, little field research has been able to investigate the effect of consumer confidence in social institutions on adoption decisions because rarely are social scientists able to track this process over time during the critical phases of knowledge acquisition and the persuasion efforts of different types of opinion leaders. This study examined consumer opinion formation over a three-month period beginning at the outset of a commercial firm's market test of irradiated beef patties. The longitudinal panel design permitted examination not only of the determinants of opinion formation, but also how changes in perceptions of innovation characteristics and compliance with endorsements from opinion leaders affected changes in opinions.

Socially Constructed Consumer Risk Assessments

The probability of risk associated with a new technology typically is characterized as assessments made by technical experts and those made by the public. Assessments made by technical experts, who usually couch their evaluations in quantitative terms, traditionally have been classified as *objective*, albeit a large volume of literature notes that much subjective guesswork and biased opinions are involved in arriving at these assessments (e.g., Freudenburg 1988). Assessments made by the public most often are considered as *subjective*. Although technical experts traditionally have thought of consumer assessments as uninformed, emotional, irrational, and even foolish (Slovic 1999), current approaches to risk communication reject this false dichotomy (Adams 1995; Beck 1992; Freudenburg 1988; Shrader-Frechette 1991; Slovic 2000) and attempt to reduce controversy by creating partnerships between technical risk assessors and the public (Fischhoff 1995), an approach that requires public trust in technical risk assessments.

Frewer et al. (1998) state that trust in information about food-related hazards might be as important as information content in influencing consumer risk assessments. Because most persons, even persons highly educated, do not have the technical expertise to fully understand quantitative risk assessments calculated by technical experts, they rely to a large extent upon trust in evaluating the quality of these assessments (Siegrist and Cvetkovich 2000). Food irradiation, for example, is a highly technical and complex process that the ordinary person cannot completely understand without being introduced to the large volume of technical information about it. Neither can the results of the process be observed. Thus, as with other technologies in the *preventive innovation* genera, in which the results are not easily visible, are delayed, or only become apparent when they fail, consumers, who do not have the expertise to decide alone, must decide whom to trust. A certain amount of faith in the efficacy of the technology is necessary as well as trust in the perceived competence of the information provider (Rosa and Clark 1999). When an innovation becomes controversial, the diffusion model posits that consumers will seek advice from others, particularly sources that are high in the competence dimension of credibility (Rogers 1995). Also, local peer opinion leaders tend not to be the early adopters of risky innovations (Becker 1970). Therefore, primary influencers of risky innovation adoption tend to be knowledgeable and trustworthy organizations (Saltiel et al. 1994; Korsching and Hoban 1990; Thomas et al. 1990).

Critical to understanding consumer opinions of complex, controversial technologies is assessing the effects of negative messages. Siegrist and Cvekovich (2001) found that information indicating a health risk of food coloring was trusted more so than messages stating no health risk and that confidence in hypothetical research results increased when they included indications of risk. Similar findings across studies of food-related and other types of technologies (e.g., Frewer et al. 1998; Taylor 1991) support the psychometric perspective that negative information carries disproportionate weight compared with positive information in influencing consumer opinions (e.g., Slovic 1999). Bord and O'Conner (1989) and Sapp and

Harrod (1990) found that negative information outweighed positive information in influencing consumer attitudes about food irradiation.

Previous research indicates also that people are more accepting of risk when it appeals to their sense of fairness, morality, and voluntariness in taking on potential hazards (e.g., Slovic 2000; Trumbo 1996). Studies (Savage 1993; Dosman, Adamowicz, and Hrudey 2001) show also that women, people with lower levels of income and formal education, and younger people, who often feel more exposed to potential hazards, tend to be more skeptical of risks associated with complex and controversial new technologies. Sapp, Harrod, and Zhao (1995) found that, while social demographic factors have significant bivariate effects on consumer acceptance of food irradiation, the partial effects of these variables were not statistically significant indicators of acceptance in comparison with the partial effects of trust in scientific experts.

Cross-Lagged Model of Symbolic Adoption

The Theoretical Model

The objectives of this study were to investigate the effects of innovation information and compliance with opinion leaders on consumer opinions and examine the determinants of changes in these opinions. The theoretical model (Figure 1) was developed to address these objectives. It specified changes in perceptions of key characteristics of food irradiation and the effects of these changes on changes in symbolic adoption from Time 1 (T1) to Time 2 (T2) (i.e., 3-month time lag, as described below). This cross-lagged, panel model specified that change in symbolic adoption is a function of changes in perceived innovation characteristics and opinion leadership influence. Compliance with opinion leaders, and leaders in health-related organizations and agencies in particular, should partially represent consumer confidence in social institutions charged with regulating a safe and wholesome food system. Social demographic characteristics are specified as control variables (Finkel 1995).

-- Figure 1 About Here--

The theoretical model addresses the first three stages (i.e., knowledge, persuasion, decision) of the innovation-decision process. The dependent variable is symbolic adoption. Klonglan and Coward (1970) define symbolic adoption as the acceptance of the idea of the innovation. They view symbolic adoption as the culmination of the evaluation of the innovation, wherein evaluation entails learning about the innovation and the positions taken by opinion leaders. Symbolic adoption represents an important juncture in the innovation-decision process because it is at this point that the principles of the innovation are considered acceptable. Subsequent implementation and confirmation decisions entail considerations of availability, trialability, financial resources, and technical support, whereas symbolic adoption represents the *affective* response to *cognitive* messages about the innovation and *social persuasion* from opinion leaders. It reflects the individual's emotional and affective responses to information messages, social persuasion, and perceived normative expectations.

The model included six variables posited as key determinants of symbolic adoption and six control variables. Relative advantage is the extent to which the innovation is considered as being better than the idea it supercedes. Compatibility is the extent to which the innovation is perceived to be consistent with existing values, experiences, and needs of potential adopters.

Complexity is the extent to which the innovation is thought to be difficult to understand and use (Rogers 1995). The diffusion of innovations model includes also as key innovation characteristics the qualities of trialability (i.e., extent to which the innovation can be experimented with on a limited basis) and observability (i.e., extent to which the innovation's results are visible to others). The trialability of purchasing the test marketed irradiated beef patties was nearly a constant because the patties were easily available in many groceries throughout the test area and subjects were informed of this fact. Although the effects of irradiation on fruits and vegetables can be highly visible (i.e., shelf-life extension), it is questionable whether consumers attribute observability to either irradiated fruits and vegetables because they do not make direct comparisons, or to irradiated meat because no visible changes occur. Therefore, these two innovation characteristics were omitted from the theoretical model. Perceived voluntariness over purchasing and eating irradiated food was added to the model because this variable has been observed to be a key psychometric indicator of consumer acceptance across many studies (Slovic 2000), including previous investigations of consumer opinions of irradiated food (Sapp et al. 1995).

Within the context of contemporary social psychological theory (e.g., Fishbein and Ajzen 1975), relative advantage, compatibility, complexity, and perceived voluntariness reflect the consumer's perceptions of facts and thereby represent *beliefs* about food irradiation. Symbolic adoption, because it encompasses an affective response to innovation characteristics, represents an *attitude*. Within the context of social psychological literature, therefore, the model focuses on belief-attitude relationships and changes that might occur in these relationships over time.

The model included two indicators of the effects of endorsements by opinion leaders. Compliance with health-related organizations/agencies reflects the influence of governmental and professional entities charged with ensuring a safe food supply. Perceived support from family and friends reflects the influence of important referent others.

The six control variables included social-demographic indicators such as the respondent's age, sex, formal education, and income. Sjöberg (1998) notes that perceived worry (which connotes an emotional response) and perceived risk (which calls for more of an intellectual judgment) are distinct concepts with differing effects on acceptance. Because the conceptualization of relative advantage and perceived risk are very similar (e.g., Titchener and Sapp 2002), the model included a control variable to account for prior worry about food irradiation (assessed on a background questionnaire prior to informing subjects that the study would focus on food irradiation). Much research addresses the manner in which the mass media present information about complex technologies and how the nature of these presentations can affect consumer opinions (e.g., Gunther 1988; Kasperson 1992), including opinions about food irradiation (Ten Eyck 1998). The market test for irradiated food received little local newspaper, radio, or television coverage during the survey period. A public radio station aired a segment that included interviews with one proponent and one opponent, and the *Minneapolis-St. Paul Star Tribune* carried two articles that announced the market testing and one letter to the Editor that expressed a favorable opinion of food irradiation. This study did not examine the content of mass media presentations or their effects on consumer opinions. Nor did it examine individual interpretations of the content of the information packet or other media presentations the subject might have encountered during the study period (e.g., Brooker and Jermyn 2002). Rather, it evaluated the effects of exposure to negative information on consumer opinions. Nevertheless, as a control variable, we assessed respondents' exposure and attention to mass media presentations on food safety.

Hypotheses

Based upon the literature on risk communication and the diffusion of innovations approach, we can use the theoretical model shown in Figure 1 to posit five key hypotheses about the sequence of events and key determinants of consumer symbolic adoption of food irradiation.

Although we do not explore the causal determinants of skepticism, based upon previous psychometric studies and the theoretical approaches regarding the effects of negative information acquisition, we posit:

> **H1**: At Time 1 (T1), persons in Condition 2 (C2) will have lower symbolic adoption of food irradiation and less favorable opinions of its innovation characteristics and voluntariness than will persons in Condition 1 (C1).

Similarly, based upon the diffusion of innovations model and empirical investigations of it, we posit:

> **H2**: Among all subjects, at T1 and T2, symbolic adoption of food irradiation will be significantly affected by perceptions of innovation characteristics.

Hypotheses 1 and 2 have received much empirical support in previous psychometric studies and evaluations of the diffusion of innovations model. Because few opportunities have arisen to examine consumer opinion formation about controversial technologies over time in a field setting, however, little empirical information exists regarding the effects of consumer compliance with social institutions and other potential opinion leaders on the symbolic adoption process. Therefore, the presumption underlying Hypotheses 3 and 4 is that, for persons in C2, the effects of negative information acquisition will be ameliorated over time because they learn that trusted opinion leaders such as the Food and Drug Administration (FDA), the American Medical Association (AMA), and the American Dietetic Association (ADA) endorse food irradiation.

H3: Among subjects in C2, compliance with opinion leaders will significantly improve symbolic adoption of food irradiation from T1 to T2.

H4: Among subjects in C2, compliance with opinion leaders will significantly improve opinions of the characteristics of food irradiation from Time 1 to Time 2.

As an additional point of interest, the study examined possible interactions among perceived complexity, compliance with organizations/agencies and family and friends, and symbolic adoption. From the literature reviewed above, it was expected that the greater the perceived complexity, the less one relies upon sources likely to be equally or less knowledgeable in favor of societal-level institutions responsible for food safety.

H5: The greater the perceived complexity of food irradiation, the greater the extent to which change in symbolic adoption will be affected by changes in compliance with organizations/agencies than by changes in perceived support from family and friends.

Methodology

The Sample

Food irradiation involves exposing food to gamma rays emitted either from a radioactive source such as Cobalt-60 or high-intensity x-rays emitted from an electron beam accelerator (Murano et al. 1995). The FDA approved irradiation for poultry, pork, flour, fruits, and vegetables in 1985 and for beef in 1999. Although the process has received extensive research support and endorsements from trusted agencies such as the AMA, the ADA, and public health agencies nationwide, it has been slow to gain consumer acceptance because negative information dissemination by opposition groups has been successful in raising consumer concerns. Until 2000, consumer skepticism was sufficient to deter retail groceries with regional or national reputations from stocking irradiated products. One observer (Golden 1997) summarized the position of retail grocers by saying, "A lot of people want to be second."

Beginning in the spring of 2000, Huisken's Meats, Inc. conducted the first large-scale, commercially funded market test of irradiated food (i.e., beef patties) in supermarkets located throughout Minneapolis, Minnesota. Data collection was initiated at the beginning of this market test. Potential respondents were selected at random from all households with listed telephones located within the Minneapolis interstate highway loop. The initial telephone contact (n = 981) asked for either a male or female adult based upon a random selection procedure. This person was asked to participate in a study of food safety (i.e., food irradiation was not mentioned at this time). Persons agreeing (n = 453) were sent a background questionnaire and an incentive fee of $15.00 to participate further. This instrument asked questions to obtain social demographic information, information about media exposure, and opinions about food safety issues. Respondents were encouraged to return a completed questionnaire as an indication they were interested in continuing with a longitudinal study. Persons agreeing to do so were sent Questionnaire 1 (Q1), at which time they were informed that the remainder of the study would focus on food irradiation.

Half the households (C2), assigned at random, received an information packet along with Q1. This packet contained two 15-minute videotapes. The first videotape (Iowa State University 1996) presented food irradiation in a favorable manner and included endorsements from the FDA, the AMA, the ADA, and representatives of other public health agencies. The second videotape (Enviro Close-Up 1993) featured an interview with Mr. Michael Colby, the Executive Director of Food & Water, Inc., the leading advocacy organization opposed to food irradiation. The information packet also contained photocopies of web pages that presented food irradiation in a favorable manner (Iowa State University 2000) along with photocopies of endorsements from the AMA and ADA, and Food & Water's (2000) *Activist's Primer*, a published booklet that presented opposition arguments to food irradiation and informed persons about how to stop it from being adopted. Persons assigned to this condition were asked to complete Q1 after reviewing the packet materials and prior to seeking additional information. Persons who did not receive the information packet (C1) were informed that others in the sample had received a packet, but they were being asked to complete Q1 and then learn about the topic on their own. Persons agreeing to participate further were sent Questionnaire 2 (Q2) three months after they returned Q1. Of the 308 persons who agreed to participate and completed Q1 (i.e., 68 percent of persons who agreed to participate over the telephone then completed Q1), 225 returned a completed second questionnaire, which represented an attrition rate of 17 percent from Q1 to Q2. Telephone calls and letters were used to reduce the attrition rate as much as possible. All subjects were informed they were not required to purchase or eat irradiated food to be eligible to participate in the food irradiation segment of the study.

Measurement of Variables

Questionnaires 1 and 2, which were nearly identical in content, asked respondents for their opinions of food irradiation, their perceptions about its safety, and other information as described below. Most variables were measured as latent constructs using Likert-type questions with seven-point response scales. The response scales were coded as 1 = [no concern, strongly disagree, etc.] to 7 = [strong concern, strongly agree, etc.] on the questionnaire, and then recoded as -3 to +3 for the analysis to clarify negative and positive opinions toward food irradiation. The statements used as observed indicators, the range of the response scales, and the reliability statistics for the latent variables appear in Table 1. Principal components factor analysis indicated that the factor structure of all latent variables was unidimensional at both T1 and T2.

--Table 1 About Here--

The measures of symbolic adoption and the other opinion variables in the theoretical model were expressed in terms of eating irradiated food, thereby establishing as close a conceptual connection as possible with the behavioral act of potential adoption (Fishbein and Ajzen 1975). Perceived complexity was measured by agreement with the statement, "I understand how food irradiation works." These responses were reverse coded, such that the higher the score, the greater the perceived complexity. The background questionnaire asked respondents to indicate how much trust they had in nineteen potential sources of food safety information. The FDA, the AMA, and the ADA were rated among the highest of all food safety information sources (average scores of 5.08, 5.59, and 5.11, respectively, on the 1-7 response scale), following only family and primary health-care providers among all potential sources. Questionnaires Q1 and Q2 asked respondents to state their compliance with these organizations/agencies regarding eating irradiated food. This compliance score was weighted by expressed trust in the potential opinion leader, which was measured with the response categories, 1 = "do not trust at all" to 7 = "trust very much." Thus, the range of possible scores for compliance with governmental/professional organizations/agencies equaled -21 (i.e., low compliance [-3] weighted by high trust [7]) to +21 (i.e., high compliance [+3] weighted by high trust [7]). Compliance with governmental/health-related organizations/agencies equaled the average of the weighted scores for the FDA, AMA, and ADA. Perceptions of influence from family (average trust score = 5.46) and friends (average trust score = 4.50) were measured in a similar manner. The respondent's perception of support from family for eating irradiated food was weighted by trust in these persons (range = -21 to +21), perception of support from friends was weighted by trust in the opinions of friends (range = -21 to +21), and these two scores were averaged to measure weighted perception of support from family and friends. Hence, our measures of opinion leadership reflected compliance with referent others weighted by level of trust in these sources of information.

The theoretical model included six control variables. Age was measured in years. Formal education was measured in five categories (less than high school, high school graduate, vocational school/technical school/some college, 4-year college degree, and post-graduate education). Total household income before taxes was measured in five categories. Perceived worry about food irradiation was assessed by a question on the background questionnaire, "How worried are you about the safety of...irradiated food?" The response to this question was weighted by expressed familiarity with food irradiation (i.e., "How familiar are you with...food irradiation?"). This weighted score (range = -21 [not worried and very familiar] to +21 [worried and very familiar]) was expected to have a negative relationship with the perceived characteristics of irradiated food and symbolic adoption of it. Because respondents were assigned randomly to the quasi-experiment conditions, this score also served as a control for the treatment effect of exposure to negative information. That is, persons in C1 (i.e., no information packet) might have been exposed, for example, to negative information about food irradiation prior to the market test and had unfavorable opinions of it. If so, their score on this variable (i.e., -21) would act as a control on their expressed opinions.

The background questionnaire asked about frequency of media exposure to food safety information (all respondents reported being exposed at least once a month to radio, television, newspapers, and magazines), and weighted this exposure by reported attention to the media when presented with this information. The response categories for frequency and attention were recorded on 10-point scales (1 = no exposure/no attention; 10 = much exposure/much attention); thus, the weighted scores on this variable ranged from 1 to 100.

The videotapes and written materials delivered to subjects assigned to C2 were selected, as much as possible, to present a balanced perspective on different viewpoints about food irradiation. It was recognized, however, that subjects might perceive the information presented to differ in the *clarity* or *quality* of videotape production or publishing format. Latent variables with seven-point response scales were constructed from two statements assessing the clarity and quality of the information packet materials (i.e., "The materials produced [at ISU; for Food & Water] were easy to understand," and "The videotape produced [at ISU; for Food & Water] was a high quality production"). Factor analysis indicated unidimensional scales for clarity and quality with reliabilities equal to .91 and .87, respectively. The percentage difference in these two latent variables (i.e., 8 percent) was used to adjust the responses of subjects who received the information packet to scores representing less favorability toward food irradiation. Analysis conducted on unweighted data yielded the same pattern of support for the research hypotheses as is reported below.

Results

The sex ratio for both conditions was biased towards females, but the extent of bias was not significantly different across conditions (Table 2). The age of the respondents and their education, income, prior worry about food irradiation, and exposure to media presentations on food safety did not differ significantly across conditions. Compared with 2000 U.S. Census figures for adults ages 18 and above, this sample was skewed toward females and over represents white people (89.6%). Analysis of the multivariate distribution of the model variables (Bollen 1989) revealed two influential outliers in C1; these observations were deleted from the analysis. The cross-lagged model was estimated based upon the covariance matrices for C1 and C2 using the LISREL 8 statistical package (Jöreskog and Sörbom 1995). Because all variables at T1 are exogenous, the model did not include potential autocorrelation effects on the estimation of endogenous variables at T2. The chi-square measures of model fit and the R-square values for the endogenous variables indicated that the model significantly fit the data for persons in C1 and C2 and explained approximately 70 and 83 percent of the variance in symbolic adoption, respectively.

--Table 2 About Here--

H1 (Effects of Negative Information)

As hypothesized, at T1, symbolic adoption of food irradiation, its perceived relative advantage over non-irradiated food, and its perceived compatibility were significantly lower ($p <$

.05) for persons in C2 compared with persons in C1 (see Table 2). These differences held also at T2. At T2, persons in C2 perceived less voluntariness over purchasing and eating irradiated food than did persons in C1. Thus, even when exposed to endorsements from representatives of trusted health-related organizations, respondents who were exposed also to negative statements delivered by a consumer advocacy group had more negative opinions of food irradiation than respondents who did not receive the information packet.

H2 (Effects of Innovation Characteristics)

At T1 and T2, relative advantage was the most important determinant of symbolic adoption (see Table 3). So, respondents seemed most concerned about the safety of irradiated food. At T1, perceived compatibility, compliance with organizations/agencies, and prior concern about food irradiation significantly affected symbolic adoption. At T2, these variables with the addition of perceptions of complexity and support from family and friends were significant indicators of symbolic adoption. Among the control variables, only prior worry about food irradiation significantly affected symbolic adoption, and this variable was a significant determinant of symbolic adoption at T1 and T2. The experimental treatment effect significantly affected the intercept of the estimation equation at T1 but not at T2. Therefore, the results of the least squares regression analysis (see Table 3) indicated that, as hypothesized, innovation characteristics played a central role in explaining the variance in symbolic adoption for persons in both experimental conditions at T1 and T2.

--Table 3 About Here--

H3-H4 (Effects of Compliance with Opinion Leaders)

Compliance with endorsements from organizations/agencies significantly improved symbolic adoption at T1 and T2, and perceived support from family and friends significantly increased symbolic adoption at T2 (see Table 3). *Shifts* in compliance with opinion leaders, however, directly influenced *shifts* in symbolic adoption from T1 to T2 only for persons in C2 (Table 4). This pattern of statistically significant and nonsignificant parameter estimates helps clarify a critical causal assumption of the study. It is unclear from examination of the results shown in Table 2 alone whether shifts in symbolic adoption occurred because of greater compliance with opinion leaders or a lessening of the effect of negative information acquisition from T1 to T2. The results of fitting the cross-lagged model, however, support the hypothesis that *change* in symbolic adoption was significantly affected by *change* in compliance with opinion leaders from T1 to T2 for persons in C2 but not for persons in C1. Recall that compliance scores were weighted by perceived trust in opinion leaders as measured on the background questionnaire. Thus, the results of fitting the cross-lagged model show shifts in compliance, but not in trust. The standardized total effects of compliance with organizations and agencies on symbolic adoption equaled .263 and .552 for persons in C1 and C2, respectively. The standardized total effects of perceptions of support from family and friends equaled .201 and .260, respectively, for persons in C1 and C2. Thus, persons in C2, who were exposed to the controversy surrounding food irradiation, relied more so than did persons in C1 on their perceptions of the viewpoints of opinion leaders, particularly the viewpoints of organizations and agencies.

Given the importance of changes in perceptions of innovation characteristics for changes in symbolic adoption, we also examined the effects of changes in compliance with and perceived support from opinion leaders on changed perceptions of these characteristics. For all subjects, increased compliance with health-related organizations/agencies significantly affected changes in perceived relative advantage and compatibility, and these changes outweighed the effects of changed perceptions of support from family and friends on shifts in relative advantage and compatibility (see Table 4). Further examination of the results of estimating the cross-lagged model showed that, for persons in both C1 and C2, shifts in perceived relative advantage were the most important determinants of changed symbolic adoption. Shifts in perceived compatibility also significantly affected shifts in symbolic adoption from T1 to T2 for all subjects (see Table 4).

Symbolic adoption by persons in C1 increased from T1 to T2, but not significantly (see Table 2). Persons in C2, on the other hand, changed their opinions significantly more in favor of the idea of food irradiation from T1 to T2. Perceptions of relative advantage and compatibility also increased significantly from T1 to T2 for persons in both conditions, and perceived voluntariness increased significantly for persons in C1. Thus, persons who knew that food irradiation was endorsed by trusted organizations/agencies shifted their opinions more favorably than did persons who did not have this information. The results of these analyses show support for Hypotheses 3 and 4.

--Table 4 About Here--

H5 (Effects of Perceived Complexity)

Contrary to Hypothesis 6, analysis of variance procedures (results not shown) showed that the greater the perceived complexity of food irradiation, the greater the extent to which shifts in symbolic adoption were influenced by changes in perceptions of support from family and friends than by compliance with organizations and agencies. We offer a potential explanation for this unexpected finding in our discussion below.

Discussion

This study examined whether risk communication strategies need to engender consumer confidence in the social institutions entrusted with regulating the food system in addition to educating the public about the technical principles of complex agricultural technologies. The results support the psychometric perspective that consumers' socially constructed risk assessments reflect the *language of risk*; that is, the presence of favorable and unfavorable comments about a new technology and the words used to express these opinions. Even when accompanied by strong endorsements from trusted health-related organizations and agencies, for example, an information packet that included statements from opponents significantly decreased consumer acceptance of food irradiation. The battlefield of socially constructed risk, however, does not seem restricted to exchanges of favorable and unfavorable messages. As predicted by the diffusion of innovations model (Rogers 1995), over time subjects seemed to be swayed by endorsements from trusted sources. It is noteworthy that persons in C2 (who received the information packet) still had negative symbolic adoption of food irradiation at T2, although their mean response was not significantly different from zero. Thus, although compliance with opinion leaders did seem to improve symbolic adoption, we cannot know if this compliance would be sufficient to gain positive symbolic adoption if a longer time period had been used to measure opinion change.

Perceived innovation characteristics significantly affected symbolic adoption, and endorsements from opinion leaders significantly influenced perceived innovation characteristics and directly affected symbolic adoption and shifts in symbolic adoption. As expected, respondents were influenced more by endorsements from organizations and agencies than by their perceived support from family and friends. Therefore, people's opinions are influenced also by their compliance with social institutions, not just by the presentation of information in the mass media or elsewhere. Also, as expected, respondents were influenced by factors other than their perceived relative advantage of food irradiation. The perceived compatibility of the technology, for example, also significantly affected its symbolic adoption.

The expected interaction between perceived complexity and reliance upon organizations and agencies was not supported. It might be that our conceptual construct of technological complexity was too narrow within the overall framework of our research. That is, our primary interest was in the effect of the messages from different types of opinion leaders on the symbolic adoption of food irradiation. These messages communicate a broad variety of information on the principles, use, and effects of food irradiation to potential adopters. Through this discourse, potential adopters develop beliefs about various characteristics of the innovation. Although we measured complexity directly, relative advantage and compatibility also represent to some degree a measure of complexity. Thus, the ability to comprehend the relative advantage and compatibility of a complex technology might be related to the potential adopter’s understanding of the nature, operation, and benefits of the technology. Rogers (1995: 225) states of compatibility, “One cannot deal with an innovation except on the basis of the familiar, what is known. Previous practice provides a familiar standard against which an innovation can be interpreted.” And of complexity he states (Rogers 1995: 242), “Some innovations are clear in their meanings to potential adopters whereas others are not.” In other words, for most individuals, the less complex the technology, the easier it should be to discern its compatibility--and its relative advantage. In our analysis, relative advantage and compatibility both contributed to the explanation of variation in symbolic adoption, and the organization variable contributed more to the explanation of variation in relative advantage and compatibility than did close acquaintances, thus lending support to this argument.

A limitation of this field experiment is that it was difficult to assess how much attention subjects paid to the information packet, precisely which elements of the packet most influenced their thinking, and how much their conversations with others during the 3-month time frame affected their responses to the final questionnaire. Although responses of subjects in C2 were weighted by their evaluations of the information materials, these evaluations do not necessarily gauge attentiveness or salience. Instead, we had to assume subjects in C2 were attentive to the videotaped and written endorsements of food irradiation made by representatives of social institutions such as the FDA, AMA, and ADA. We had no reason to believe that the two groups of subjects varied significantly in their ability to access additional information.

The results here indicate that people comply with opinions expressed by organizations and agencies responsible for evaluating new technologies. Thus, if the quality of the social fabric--as indicated by sense of confidence in social institutions--influences the nature and outcome of public discourse about complex and controversial agricultural technologies, then social scientists should monitor how changes in institutional relationships and affiliations might affect consumer confidence in organizations/agencies typically looked to for opinion leadership. Examinations of the efficacy of and implications for the quality and nature of research conducted within university-industry relationships (Busch 2000; Ervin 2003), for example, can inform the public, diverse stakeholders, academicians, and policymakers about effective ways to build collaborative partnerships while maintaining public confidence in the social institutions often looked to for opinion leadership regarding new agricultural technologies.

Fischhoff (1995) notes that risk communication strategies have moved well beyond the present the facts to the public and let them learn and decide approach to strategies that foster partnerships among technical experts and laypeople. He maintains that it is unrealistic to avoid conflict; indeed, conflict is legitimate when some people are bearing disproportionate risk. The best approach to risk management, he argues, is "having fewer, better conflicts" (p. 144), ones guided by scientific principles that include consideration of social issues. Similarly, Short (1999) argues for greater society-level involvement in the protection of the social fabric. Our results indicate that gaining a better understanding, not only of the effects of risk communication but also of relationships between citizens and their social institutions and how these relationships affect socially constructed risk assessments, might improve risk management and perhaps the social fabric upon which effective risk assessment and management depend. Therefore, risk communication research perhaps should be broadened to include more extensive study of the interactive dynamics that likely will foster consumer confidence in the food system--but not necessarily in any particular technology.

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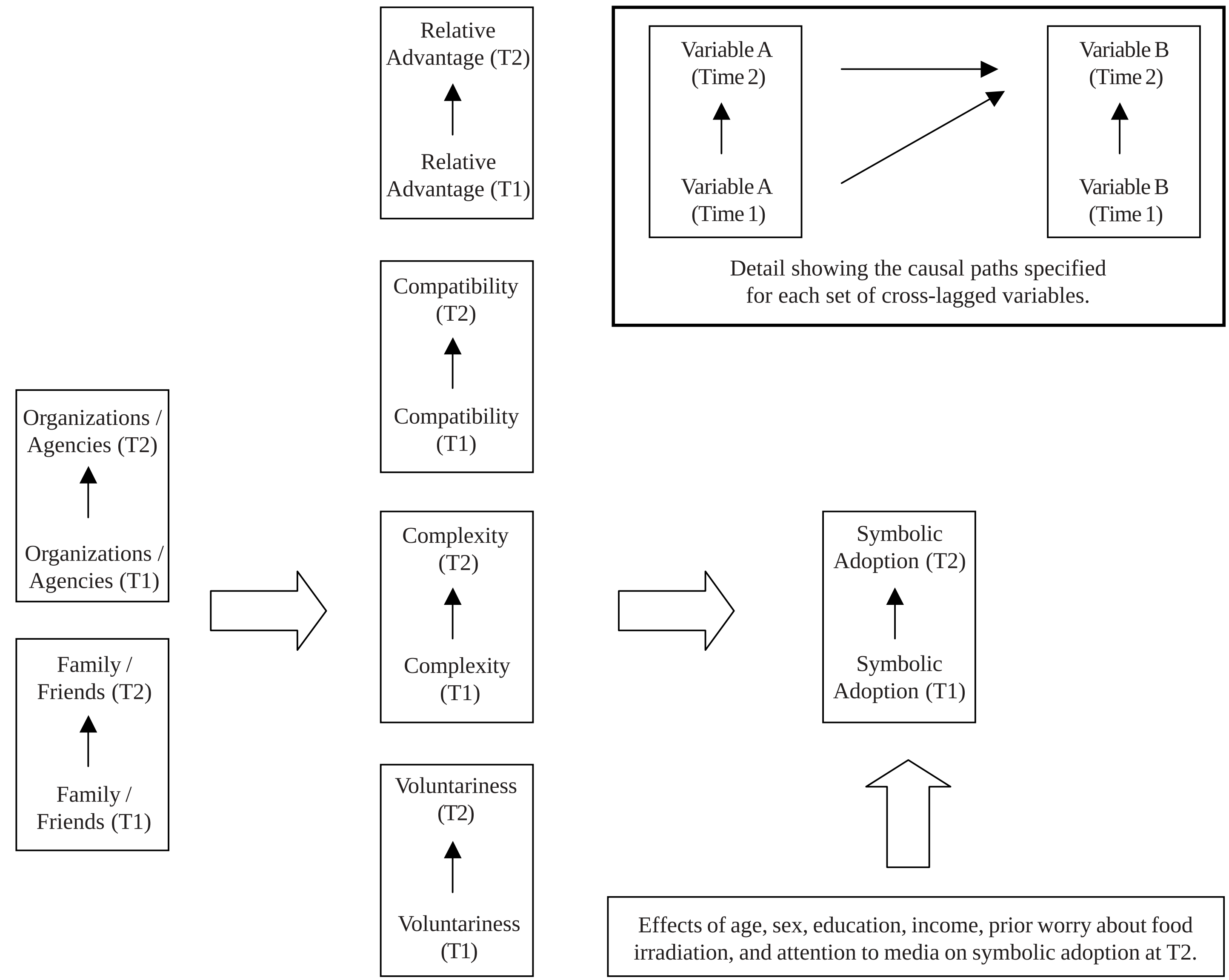

Figure 1. Cross-Lagged Model of Opinion Leadership and Innovation Characteristics on Symbolic Adoption of Irradiated Food.

Table 1. Description of and Cronbach Reliability Estimates for the Latent Dependent and Independent Variables at Time 1 and Time 2

Variable	Description	Reliability Time 1	Reliability Time 2
Symbolic Adoption Range: -3 to 3	I think that eating irradiated food is a good idea. The idea of eating irradiated food frightens me.[1] For me, eating irradiated food would be good. For me, eating irradiated food would be desirable.	.93	.90
Relative Advantage Range: -3 to 3	Eating irradiated food will be safer than eating non-irradiated food. Eating irradiated food will be safer for small children than eating non-irradiated food. Eating irradiated food will be safer for elderly persons than eating non-irradiated food.	.88	.85
Compatibility Range: -3 to 3	Most persons will be in favor of eating irradiated food. Eating irradiated food likely will be accepted by the American public. Eating irradiated food fits my lifestyle.	.75	.74
Voluntariness Range: -3 to 3	The final decision about whether to eat irradiated food will be up to me. I will have the final say-so over selecting irradiated foods at the grocery where I shop. I have control over whether I eat irradiated foods.	.76	.84
Orgs./Agencies[2] Range -21 to 21	If the Food and Drug Administration approves of food irradiation, then I can go along with it. If the American Medical Association approves of food irradiation, then I can go along with it. If the American Dietetic Association approves of food irradiation, then I can go along with it.	.85	.82
Family and Friends[2] Range: -21 to 21	My family thinks I should eat irradiated food. My friends think I should eat irradiated food.	.89	.87

1. Coding reversed in the analysis.
2. This variable was weighted by trust in the referent others.

Table 2. Descriptive Statistics for the Model Variables by Time and Condition

		Mean Scores			
		Time 1		Time2	
Variable	Range	*Condition 1* (n=107)	*Condition 2* (n=116)	*Condition 1* (n=107)	*Condition 2* (n=116)
Symbolic Adoption	-3 to 3	0.10	-1.17[a,b]	0.26	-0.38[a,b,c]
Relative Advantage	-3 to 3	-0.22	-1.32[a,b]	-0.01	-0.59[a,b,c]
Compatibility	-3 to 3	-0.62[a]	-1.50[a,b]	-0.45[a]	-0.83[a,b,c]
Complexity	-3 to 3	0.64[a]	-1.38[a,b]	0.74[a]	-0.91[a,b]
Voluntariness	-3 to 3	1.24[a]	1.18[a]	1.54[a,c]	0.83[a,b]
Orgs./Agencies	-21 to 21	0.64	-5.38[a,b]	1.76[a,c]	-1.44[a,b,c]
Family and Friends	-21 to 21	-8.67[a]	-11.12[a]	-8.65[a]	-8.59[a,c]

Descriptive Statistics for the Control Variables[d]

	Condition 1	*Condition 2*
Age	Mean = 52.91	Mean = 50.89
Sex	Males = 42 (39.3%)	Males = 44 (37.9%)
Education	Mean = 3.49 (post h.s. to college)	Mean = 3.54 (post h.s. to college).
Income	Mean = 2.88 (approx. $46,500)	Mean = 3.05 (approx. $50,750)
Prior Worry	Mean = -1.904	Mean = -1.346
Attention to Media	Mean = 37.27[a]	Mean = 33.72[a]

a. The mean score is statistically different than the mid-point of its response scale at $p < .05$.
b. The difference in mean scores between conditions within a time period is statistically significant at $p < .05$.
c. The difference in mean scores between Time 1 and Time 2 within conditions is statistically significant at $p < .05$.
d. There was a statistically significant difference in the number of male and female respondents; but this biased sex ratio was not significantly different across conditions. None of the differences in age, education, income, prior worry, or attention to media between conditions was statistically significant at $p < .05$.

Table 3. Standardized Parameter Estimates for the Regression of Symbolic Adoption on Innovation Characteristics, Opinion Leadership, and Control Variables by Time (n = 223)

	Time 1	Time 2
Relative Advantage	.538**	.388**
Compatibility	.102*	.219**
Complexity	-.054	-.092*
Voluntariness	-.047	.020
Orgs./Agencies	.138**	.173**
Family/Friends	.034	.092*
Age	.093	.036
Sex	-.039	.001
Education	.021	.042
Income	.039	-.003
Prior Worry	-.179**	-.148**
Attention to Media	-.121**	-.018
Condition	-.102*	-.080
F-ratio	49.24**	42.88**
Adjusted R-Square	.739	.710

* Estimate or F-ratio is statistically significant at $p < .05$.
** Estimate or F-ratio is statistically significant at $p < .01$.

Table 4. Standardized Direct Effects of the Cross-Lagged Variables on Changes in Symbolic Adoption and Innovation Characteristics by Condition

Condition 1 (No Information Packet) n = 107.

Variable	Symbolic Adoption	Relative Advantage	Compatibility	Complexity	Voluntariness
Relative Advantage	.268*				
Compatibility	.218**				
Complexity	-.087				
Voluntariness	.016				
Orgs./Agencies	.128	.288**	.293**	-.019	.159
Family/Friends	.069	.201*	.297**	-.204*	-.061

R-square for symbolic adoption = .698. Chi-square = 99.950 (d.f. = 149), p = .999.

Condition 2 (Information Packet) n = 116.

Variable	Symbolic Adoption	Relative Advantage	Compatibility	Complexity	Voluntariness
Relative Advantage	.394**				
Compatibility	.101				
Complexity	-.054				
Voluntariness	.075				
Orgs./Agencies	.171*	.566**	.399**	.001	.450**
Family/Friends	.122*	.134*	.297**	-.160	.188*

R-square for symbolic adoption = .790. Chi-square = 154.895 (d.f. = 149), p = .354.

* Parameter estimate is statistically significant at $p < .05$.
** Parameter estimate is statistically significant at $p < .01$.