Risk Analysis, Vol. 32, No. 4, 2012 DOI: 10.1111/j.1539-6924.2011.01645.x

Communicating Actionable Risk for Terrorism and Other Hazards*

Michele M. Wood,[1,*,†] Dennis S. Mileti,[2] Megumi Kano,[3] Melissa M. Kelley,[3] Rotrease Regan,[3] and Linda B. Bourque[3]

We propose a shift in emphasis when communicating to people when the objective is to motivate household disaster preparedness actions. This shift is to emphasize the communication of preparedness actions (what to do about risk) rather than risk itself. We have called this perspective "communicating actionable risk," and it is grounded in diffusion of innovations and communication theories. A representative sample of households in the nation was analyzed using a path analytic framework. Preparedness information variables (including content, density, and observation), preparedness mediating variables (knowledge, perceived effectiveness, and milling), and preparedness actions taken were modeled. Clear results emerged that provide a strong basis for communicating actionable risk, and for the conclusion both that information observed (seeing preparedness actions that other have taken) and information received (receiving recommendations about what preparedness actions to take) play key, although different, roles in motivating preparedness actions among the people in our nation.

KEY WORDS: Diffusion theory; disaster; path analysis; preparedness; risk communication

1. INTRODUCTION

1.1. Problem and Purpose

We live in an era of information abundance and communication evolution; the information to which we have access is growing exponentially, and the ways in which it is received and shared are transforming. The number of information campaigns to motivate public preparedness for terrorism and other hazards throughout the nation is large,[1] and the diversity of channels for communicating such information is increasing. Growing penetration of the Internet and social media has led to a greater number of websites to disseminate this information. Moreover, in our increasingly uncertain and complex world, there are a great many types of hazards for which one ought to prepare, including terrorism and natural and technological hazards.

Efforts to influence public preparedness behavior (i.e., developing emergency plans, stockpiling supplies, purchasing things to be safer, duplicating important documents, etc.) by communicating information to the U.S. public are varied and based on different kinds of knowledge. The majority of education campaigns that inform the public about risk

*Approvals of the study protocol were obtained from Institutional Review Boards at participating institutions to ensure the ethical treatment of research participants.

[1]Department of Health Science, California State University, Fullerton, CA, USA.
[2]Department of Sociology and Natural Hazards Center, University of Colorado at Boulder, CO, USA.
[3]School of Public Health, University of California, Los Angeles, CA, USA.
†Michele Wood was affiliated with the University of California, Los Angeles School of Public Health, Department of Community Health Sciences at the time of data collection, and with the California State University, Fullerton, Department of Health Science at the time of data analysis and article preparation.
*Address correspondence to Michele Wood, Department of Health Science, California State University, 800 N. State College Blvd, Fullerton, CA, USA; mwood@fullerton.edu.

0272-4332/12/0100-0601$22.00/1 © 2011 Society for Risk Analysis

and disaster preparedness in place today, however, are largely shaped by intuition about what is important, anecdotal experience, and/or the familiar. Although it feels good, our intuition about how to motivate behavior change often misses the mark. Anecdotal experience of isolated events may not generalize. In the case of repeating the familiar, people continue to do what previously has been done, even when what has previously been done has not been particularly effective.[2] There has been a dearth of evidence-driven policy shaping the design of public education campaigns about hazards and substantial underuse of theory from the social and behavioral sciences to inform such efforts.[3]

The potential impact of policy decisions to design and implement disaster preparedness campaigns that are theory driven and based on sound empirical evidence is great. Recent catastrophic events seem numerous and extraordinary. The terrorist events of September 11, 2001 killed 2,973 people, excluding the terrorists.[4] The events were unique in the nation's history and affected many Americans intensely, including those who were not directly harmed. The December 2004 Sumatra–Andaman tsunami was triggered by an earthquake that registered 9.2 (Richter scale) and was one of the most devastating natural disasters in recorded history, killing an estimated 230,000 people.[5] Hurricane Katrina in August 2005 was the deadliest U.S. hurricane since 1928, flooded 80% of the city of New Orleans, and was responsible for more than 1,500 deaths.[5,6] The Haiti earthquake in January 2010 was 7.0 in magnitude, killed an estimated 230,000 people, and left more than 3.5 million displaced.[7] The death toll from the March 11, 2011 Tohoku, Japan earthquake (magnitude 9.0) and the resulting tsunami and nuclear crisis is yet unknown.[8] There is no shortage of reminders of why people should prepare.

Furthermore, natural hazards are becoming more hazardous because of persistent development and increasing density in vulnerable settings.[9,10] Meanwhile, concerns about future terrorist attacks persist. In fiscal year 2010, the Department of Homeland Security Grant Program (HSGP) dedicated $832.5 million towards the Urban Areas Security Initiative (UASI) to enhance regional preparedness in major metropolitan areas; at least 25% of funds have been designated for law enforcement and terrorism prevention.[11] Public education about risk for terrorism and other hazards as well as recommended preparedness actions are paramount. Indeed, the stakes are high, and at no point in our nation's history has communication to motivate public preparedness for high-consequence low-probability events been in greater use or more visible as a political centerpiece. Yet despite the prominence of information and communication about preparedness for terrorism and other disasters, we lack clear evidence-based knowledge of the underlying process through which public education information is transformed into consequent desired behavior change. We remain uncertain as to how we can maximize public preparedness action resulting from our risk-communication-based interventions despite the availability of rich theoretical frameworks that could inform policies and programs.

1.2. Theoretical Orientation

Communication about risk is a broad area of inquiry and involves diverse disciplines, frameworks, and theoretical orientations.[12] Disciplines include psychology, sociology, medicine, public health, public policy, cognitive science, risk management, and more.[13] Moreover, different labels and emphases are employed, e.g., in public health risk communication is known as "health education";[14] in psychology, "risk perception" is studied. Many discipline tributaries have asked questions like the one that is the focus of this article: *How should public education campaigns be designed to get the public to prepare for future disasters?*

A variety of theoretical orientations exists that could be used to inform research and practice focused on communicating information to motivate public preparedness behavior. These include individual, interpersonal, and community/group approaches. Individual-level theories consider the role individuals play in their own behavior and focus on internal factors.[15,16] Examples include the theory of planned behavior,[17,18] the heath belief model,[19,20] and protection motivation theory.[21,22] Interpersonal-level theories consider the role other people have on individual behavior and focus on external factors.[15,16] Social cognitive theory is a prominent example.[23] Such theories suggest that the behavior of individuals can be influenced by changing the norms that guide behavior. Community- and group-level theories instead understand behavior in the context of social institutions and communities, and focus on factors within social systems.[15,16] Examples include community organizing and

community building,[24] diffusion of innovations,[25–28] and communication theory.[29,30]

For the explicit purpose of guiding communication campaigns and mass media efforts to change health behavior, community and group models that have a "social diffusion" perspective, such as[31] diffusion of innovations[25–27] and communication theories,[29,32,33] can be especially helpful. Diffusion of innovations defines an *innovation* as an idea, practice, or object perceived as new, and *diffusion* as "the process by which an innovation is communicated through certain channels over time among members of the a social system" to maximize program reach.[27] Diffusion happens in a sequence of five stages—knowledge, persuasion, decision, implementation, and confirmation—and can occur over interpersonal or mass media communication *channels* or mediums. Alternatively, communication theory examines "who says what in which channel to whom and with what effects?"[32] Communication frameworks highlight the importance of information source, message, and channel, and how exposure to messages can affect behavior. In general terms, risk communication is a specialized subarea within communication theory that has been defined as the "purposeful exchange of information about health or environmental risks between interested parties."[34] It typically involves transmitting information about the level and significance of risks as well as decisions, actions, or policies to manage them.

Diffusion of innovations and communication theories can help guide information campaigns to motivate preparedness because they can inform campaign structure and help explain the process through which people receive and then respond to information by taking action. In addition, the social diffusion orientation implicit in both theories incorporates constructs from individual-level models as mediating variables.[29] Hence, these frameworks are ideally suited to guide "intervention-focused" research since they provide a perspective that informs conceptualizing the elements of public education campaigns about disaster preparedness that can be studied.

Although some have linked the first structured risk analysis to the Babylonians in 3200 BC,[35] the term "risk communication" became an established presence in the academic and policy literature in 1986.[14,36] The "professionalization of risk" has been traced to three developments: (1) the rise of the modern state in the late 18th century, (2) the development of public health institutions in the 20th century, and (3) decision analysis, which emerged and was refined between the 1940s and late 1960s.[14] When the Environmental Policy and the Occupational Health and Safety Acts were passed in 1969 and 1970, and the Office of Technology Assessment was created in 1972, the institutionalization of risk analysis in the United States was complete. The need for defensible risk assessments increased, as did graduate coursework emphasizing decision analysis. Research focusing on risk perception cognitions and risk behavior in psychology, and on societal protective behaviors in sociology, ensued. Thus far, however, despite a large literature, risk communication research has yielded few definitive empirical results.[37] The theoretical challenges we face today are similar to those we faced in the 1980s: we must bring existing empirically validated theory from the social and behavioral sciences to bear on the demand for increased public preparedness to produce an evidence-based approach.[2,12,38]

What is of critical importance to the nation, though absent, is an empirically validated model of *actionable* risk communication—one that facilitates action by the general public—that can frame education campaigns for public preparedness. A model that draws on existing theory and focuses on those parameters that can be directly manipulated by public education campaigns would be useful in guiding future efforts to educate the general public about preparing for disasters and holds the potential to be more effective than the well intended but all too often unempirical bases for such efforts.[2] It is our purpose to build and test such a model.

1.3. An Actionable Risk Communication Model

Social science research into how communicating risk information to the public to motivate household preparedness action-taking began almost 40 years ago. Initial research was conducted on a range of hazard types, for example, tsunamis,[39] floods,[40] and hurricanes.[41] However, most research examined the public information-to-action linkage for earthquakes;[42,43] and was conducted in a variety of contexts that included after-quakes;[44] after predictions of "pending" earthquakes;[45,46] and during more "general times" when no event had occurred or had been predicted.[44] Not surprisingly, most of this research was conducted in California, it varied by community type, and included rural communities[47] as well as large urban centers.[43–45,48] Inquiry into how information motivates household preparedness action-taking for terrorism has only recently begun.[49]

Regardless of hazard type, the key question that underlies both theory and practice is behavioral: What can public information best say and how can it best be made available to reach, teach, and motivate people to prepare for future disasters that most think will not really happen, and, if they do, they think will happen to other people and not them? Many believe they are not at risk of high-consequence, low-probability events, and perceptions of being safe are reinforced every day a disaster does not occur. Perceptions of "being safe" change to those of "being at risk" immediately after the occurrence of a community-wide disaster. In fact, historical evidence suggests that experiencing a disaster may be the strongest public motivator to prepare, albeit after the event. The phenomenon has been popularized by practitioners as "the window of opportunity." However, the window quickly closes as the effect of experiencing an event on motivating preparedness declines as time passes, and perceptions of safety reemerge and rise back to preevent levels, typically within a two-year period.[50–52]

To inform the use of public information, the communication and diffusion of innovations theoretical frameworks combined with a review of empirical findings identified seven pertinent constructs to include in a model predicting household preparedness action as a result of public education campaigns.

1.3.1. Content of Preparedness Information Received

A fundamental tenet of general communication theory is that information received is a key motivator of future action.[53] The research record provides clear findings on the role of communication in motivating public preparedness in the absence of actual disasters and has identified information received as a strong motivator of household preparedness action-taking. Information provides the strongest motivation to those who receive it if its content is focused on providing specific guidance about what actions to take,[44,45,54–57] and if it explains how those actions cut future losses.[58]

1.3.2. Density of Preparedness Information Received

Diffusion of innovations[25,27,28] and communication[29] theories both assert that noncontent attributes of "information received" also are important. According to both frameworks, the degree to which information is available across different sources and channels influences the likelihood of future action-taking. Empirical studies have shown that to be effective, preparedness information must: come from multiple sources,[47,59] be communicated over multiple channels of communication,[60–62] and be frequently repeated.[44,63–65]

1.3.3. Consistency of Information Received

Prior research[45,47,66] has also clearly concluded that a third exogenous information variable—consistency across different messages including those from different sources and over time—is an important predictor of preparedness action-taking. Stated simply, conflicting information creates confusion among those who receive it and constrains action-taking. In diffusion of innovations theory, dissonance occurs when the adoption of an innovation is questioned or there is conflicting information, resulting in the innovation being discontinued or rejected.[27] The importance of information consistency is implicit in the communication theory framework.[29]

1.3.4. Preparedness Action Information Observed

A fourth information factor is "information observed" or cues such as seeing other people getting ready.[45–47,67] The impact of "seeing" others, especially close acquaintances, prepare is generally a stronger motivator for preparedness and mitigation action-taking than reading or hearing about the need to take actions. Diffusion of innovations theory holds that if the results of adoption of an innovation are observable, the innovation is more likely to be adopted.[27]

1.3.5. Knowledge of Preparedness Actions

Communication and diffusion of innovations theories alike note the necessary role of knowledge in driving future actions.[25,28,29] Thus, knowledge is a precursor to taking action to prepare for future disasters[68] and has been correlated with both intention to perform preparedness actions and self-reported preparedness behavior.[69] Persuasive communication takes aim at knowledge to influence attitudes toward adopting preparedness behaviors.[70]

1.3.6. Perceived Effectiveness of Preparedness Actions

The perceived effectiveness of recommended preparedness actions also influences behavior.

Diffusion of innovations theory asserts that innovations that either accomplish something desired by filling a void where no alternative exists or by doing so more effectively are more likely to be adopted because of their "relative advantage."[27,28] People who think preparedness measures are useful[71] or will protect people or property effectively[69,72,73] are more likely to adopt them. For example, mathematical models have shown that household preparedness actions for earthquakes are more highly correlated with the perceived effectiveness of those actions than with perceived risk.[74]

1.3.7. Milling About Preparedness Actions

In the diffusion framework, "confirmation" is a process by which individuals seek to affirm their decision to adopt an innovation.[27] According to communication theory, after information has been disseminated at the macro level, interpersonal communication at the micro level can influence whether or not individuals adopt a recommended action.[29] The literature clearly documents that preparedness is the consequence of information that first motivates people to engage in searching behavior or "milling" in their environment and interacting with others to affirm the appropriateness of taking preparatory behavior.[45,47,75,76] Perhaps this is because information seeking allows people to have a sense of control of their own response to risk communications and to perceive their actions as self-driven.

1.4. Synthesized Model

The model we assembled to represent a theory of communicating actionable risk proposes that: (1) knowledge is a function of information content, information density, information consistency, and information observed (cues); (2) perceived effectiveness of preparedness actions is a function of information content, information density, information consistency, information observed, and knowledge; (3) milling is a function of information content, information density, information consistency, information observed, knowledge, and perceived effectiveness; and (4) taking preparedness actions is a function of information content, information density, information consistency, information observed, knowledge, perceived effectiveness, and milling.

1.5. Estimated Model

The model we estimated—in its saturated form—is presented in Fig. 1. It excluded the variable of information consistency across messages received because this variable's impact was reduced to nonstatistically significant levels when included in early estimations of the model; including it would have biased other estimates. Variables in the model were ordered as described above and presented in Fig. 1 for the following reasons. First, we considered the three information variables exogenous because our purpose was to explore their influence on preparedness actions taken. Second, we positioned preparedness actions taken as the endogenous variable in the model because it is the behavior we wished to explain. Third, we positioned milling immediately prior to preparedness actions taken because there is clear evidence for this in the literature as documented in three separate communities.[61] Fourth, we positioned knowledge of preparedness actions immediately after the three information variables and prior to any other mediating variables in the saturated model because perceived effectiveness of preparedness actions cannot logically precede knowledge of those preparedness actions. Finally, we included every possible mediating relationship in the saturated model before we estimated it (Fig. 1).

2. METHOD

2.1. Sample

The sample used in this research was statistically representative of the population of the continental United States. It was stratified into: (1) high terrorism visibility areas (Washington, D.C. including the District of Columbia, Arlington, Fairfax, Prince William, Loudoun, Montgomery, and Prince George's counties; Los Angeles County; and New York City, consisting of the Bronx, Brooklyn, Manhattan, Queens, and Staten Island, which were oversampled; and (2) lower terrorism visibility areas defined as the rest of the continental United States. To account for the differential selection probabilities associated with the sample design, the sample was weighted using dual-frame methods calculating sampling weights that are inversely proportional to selection probabilities and scaled to sum to the sample size, 3,300. To bring the distributions of key demographic characteristics into conformance with national population totals, the sample weights were then "raked" using WesVar software[59] so that the weighted demographics matched population control values and to help mitigate potential biases associated with undercoverage of populations that use cellular telephones exclusively.[60–66]

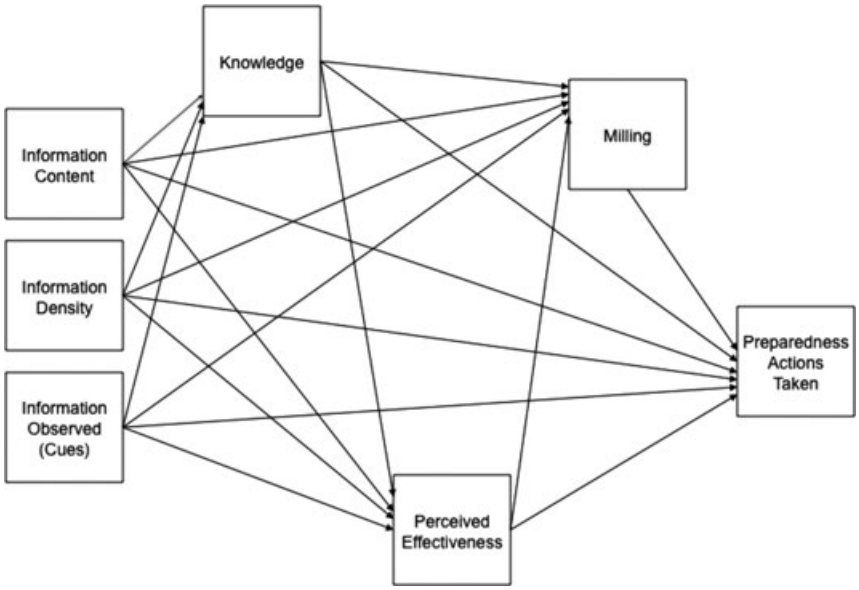

Fig. 1. Theoretically derived model of actionable risk communication and its effect on proactive risk reduction behavior.

Respondents for whom data were missing on income ($n = 180$), age ($n = 57$), race/ethnicity ($n = 119$), years of schooling ($n = 10$), birthplace ($n = 9$), or any of the model variables ($n = 218$) were deleted listwise from the sample leaving no cases in the analytical sample that have missing data on any of the variables analyzed, including the items composing indexes. The unweighted sample includes 2,772; the weighted sample represents 2,811. Table I shows how the sample, weighted and unweighted, compared with U.S. Census Projections for 2007. Of particular note is the fact that the percent of respondents living in the high visibility areas of Washington, D.C., New York City, and Los Angeles County dropped from 6% to 12% in the unweighted sample to only 1–3% in the weighted sample, which is close to the U.S. Census projections of 1.4–2.9% for 2007. Race/ethnic distributions were comparable to 2007 projections in both the weighted and unweighted sample, but persons under 45 years, those with no more than a high school education, and those with lower household incomes were underrepresented in the unweighted sample. Women were overrepresented regardless of whether the sample was weighted or unweighted.

2.2. Questionnaire Construction, Pretesting, and Data Collection

The questionnaire was constructed, seven pretests were conducted with project employees and their acquaintances, followed by revisions. To finalize the questionnaire, 20 more pretests were conducted in three iterations with individuals drawn from the high terrorism visibility stratum, and the finalized questionnaire was translated to Spanish. Interviewers received project-specific training including study objectives, probing techniques, item-by-item review, and "mock" interviews. Random silent monitoring of no less than 7% of interviews was conducted. Supervision allowed for review of interviewer screens and interviewer/respondent conversation and for staff training focused on issues identified during monitoring.

Data were collected over the course of 10 months (April 13, 2007 to February 13, 2008) using computer assisted telephone interviewing (CATI) methods, in English or Spanish at the request of the respondent. Participants were offered their choice of a gift card or donation in their name ($20) to one of three charities. Up to 11 call attempts on different days at different times were made. Interviews were conducted with an adult resident, selected using the "last birthday" method, in 3,300 households.[77] The response rate was 35%, calculated as the ratio of unweighted completion cases to estimated eligible cases.[78]

2.3. Measurement and Scaling

Answers to multiple questions were combined to create indices using exploratory and confirmatory factor analysis and tested using Cronbach's alpha.[79]

Table I. Sample Description (Unweighted, Weighted, and Census Data)

	Unweighted Sample[a] (%)	Weighted Sample[b] (%)	U.S. Census Projections for 2007[a] (%)
Geographic area			
Washington, D.C.	6.1	1.1	1.4
New York City	11.1	2.6	2.7
Los Angeles County	12.7	3.1	2.9
Rest of the U.S.	70.1	93.2	93.0
Nationality (U.S.)	85.9	88.5	84.6
Race/ethnicity			
Asian American/Pacific Islander	3.6	4.5	3.8
Black/African American	10.7	12.1	11.1
Hispanic	13.1	11.1	10.8
White/other	72.6	72.3	73.7
Gender (women)	61.5	62.7	50.8
Age (years)			
Under 35	19.9	21.4	21.0
35–44	19.4	21.8	20.7
45–54	22.6	21.4	21.6
55–64	19.4	16.5	16.4
65 and older	18.7	18.9	20.4
Education level			
Less than high school	9.4	9.5	14.2
High school graduate	25.5	31.6	28.2
Some college education	24.2	22.1	28.8
College graduate	40.9	36.8	28.8
Household income (dollars)			
<15k	10.6	12.2	14.8
15k–<25k	9.8	9.6	11.4
25k–<35k	10.8	10.0	11.2
35k–<50k	13.6	17.9	14.8
50k–<75k	18.3	18.2	19.0
75k–<100k	14.0	13.7	11.8
100k – <150k	13.5	12.1	10.9
≥150k	9.4	6.5	7.0
Household with child(ren) <18 (yes)	38.1	38.3	34.6
One-person household (yes)	22.9	33.8	27.3
Single-family unit housing (yes)	66.0	62.9	68.8
Owner-occupied residence (yes)	67.9	67.8	67.3

[a]The unweighted analytical sample is the 2,772 of 3,300 respondents for whom complete data on demographic and model variables were available. $N = 300{,}913{,}000$ for the U.S. Census population projection for 2007. "Other" includes "other racial/ethnic group," "don't knows," and respondents who refused to give race/ethnicity.

[b]$N = 2{,}811$ for the weighted sample. The weighting was: (1) designed to account for the differential selection probabilities associated with the sample design (by calculating sampling weights that are inversely proportional to selection probabilities, and scaled to sum to the sample size, 3,300), and (2) intended to bring the distributions of key demographic characteristics into conformance with national population totals (using WesVar software from Westat, in Rockville, Maryland, to "rake" the sampling weights so that the weighted demographics matched population control values). Both individual weights and household weights, with and without raking, were calculated.

Factor analysis in SPSS (Varimax rotation) assessed whether the items reliably represented a single construct. Scree-plot and eigenvalues size were examined to determine the maximum number of possible factors for the potential items. Factor loadings were assessed, and items that cross-loaded across factors were dropped. Two factors were extracted from each measure; one represented "proactive" actions, the other represented the "avoidance" actions. (This article focuses on proactive behavior, thus avoidance actions were not included in the analyses.) Coefficient alpha values ranged from 0.64 to 0.93. Skewness ranged from –0.57 to 0.91. Kurtosis ranged from −0.59 to 2.09. The variables in the model were operationalized as follows.

"*Content of Preparedness Information Received"* was measured by asking respondents four questions using the same item "stem." Items that compose

the index include: "Still thinking about information that you happened to get and not information you actively went looking for since September 11, 2001, what kinds of information have you gotten? Have you gotten information about: (1) Developing emergency plans (evacuation, meeting places)? (2) Stockpiling supplies (food, water, antibiotics, etc.)? (3) Purchasing things to make you safer (gas masks, duct tape, things to make your house safer, etc.)? (4) Duplicating important documents (birth certificate, medication prescriptions, and passports)?" Responses were recorded as "Yes/No"; an index was created by summing the "yes" responses, which varied between 0 and 4.

"Density of Preparedness Information Received" was measured by asking respondents three questions about sources and three questions about channels of information. For sources, respondents were asked: "Please think about information that you have happened to get about preparing for terrorism or terrorist events since September 11, 2001. This does not include information that you actively went looking for. Have you heard information about protecting yourself from terrorism from: (1) Friends or relatives? (2) Employers? (3) The Department of Homeland Security?" For channels, respondents were asked: "How was this information communicated to you? (4) Did you read it in newspapers? (5) Have you heard information from TV anchors or reporters and/or did you see it on television? (6) Did you hear information from radio hosts or reporters and/or hear it on the radio?" Answers were recorded as "Yes/No"; an index was created by summing the "yes" responses which varied between 0 and 6.

"Preparedness Action Information Observed" was measured by asking respondents four questions using the same stem. Items that compose the index include: "Do you know anyone, not including yourself, who has: (1) Developed emergency plans (evacuation, meeting places)? (2) Stockpiled supplies (food, water, antibiotics, etc.)? (3) Purchased things to make you safer (gas masks, duct tape, things to make your house safer, etc.)? (4) Duplicated important documents (birth certificate, medication prescriptions, and passports)?" Responses were recorded as "Yes/No"; an index was created by summing the "yes" responses, which varied between 0 and 4.

"Knowledge of Preparedness Actions" was measured by asking respondents eight questions using the same stem. Items that compose the index include: "Would you say you know '1, nothing', '5, a lot', or you may use any number in between? How much do you know about: (1) What you can do to prepare for terrorist events? (2) Where to get information about preparing for terrorist events? (3) What the government recommends you do to protect yourself against terrorism or a terrorist attack? (4) What you can do now to reduce damage from a possible terrorist event? (5) How to protect yourself in a terrorist attack that used a biological agent? (6) How to protect yourself in a terrorist attack that used a chemical agent? (7) How to protect yourself in a terrorist attack that used a radiological agent? (8) How to protect yourself in a terrorist attack that used an explosive agent?" Index scores, which varied from 1 to 5, were calculated by summing the answers and calculating the mean score.

"Perceived Effectiveness of Preparedness Actions" was measured by asking respondents four questions using the same stem. Items that compose the index include: "How effective do you think (1) developing emergency plans (evacuation, meeting places) is for people dealing with terrorism? Would you say '1, not at all effective', '5, extremely effective', or you may use any number in between? (2) Stockpiling supplies (food, water, antibiotics, etc.)? (3) Purchasing things to make you safer (gas masks, duct tape, things to make your house safer, etc.)? (4) Duplicating important documents (birth certificate, medication prescriptions, and passports)?" Index scores, which varied from 1 to 5, were calculated by summing the answers and calculating the mean score.

"Milling About Preparedness Actions" was measured by asking respondents five questions. First: "Now I want to know if you have actively looked for information about preparing for a future terrorist act. After the initial response to September 11, 2001 was over, how frequently did you try to get information about terrorism: At least daily? At least weekly? At least once a month? At least once a year? Never?" Responses were recoded to indicate whether the respondent had actively sought information. Individuals who responded "never" were recoded as "no"; those who responded otherwise were recoded as "yes." Second, respondents were asked: "Did you actually get any information?" Third: "Did you understand the information you got?" Fourth: "Did you think about the information you got?" Fifth: "Did you discuss the information that you got with other people?" Responses to items 2 through 5 were recorded as "Yes/No." An index of 0–5 was created by summing "yes" answers.

"Preparedness Actions Taken" was measured by asking respondents four questions using the same item stem. Items include: "Have you: (1) Developed emergency plans (evacuation, meeting places)? (2) Stockpiled supplies (food, water, antibiotics, etc.)? (3) Purchased things to make you safer (gas masks, duct tape, things to make your house safer, etc.)? (4) Duplicated important documents (birth certificate, medication prescriptions, and passports)?" Responses were recorded as "Yes/No"; an index varying from 0 to 4 was created by summing the "yes" responses. Additionally, respondents were asked why they took each preparedness action (because of terrorism, natural disasters, and/or other reasons). The index used in this analysis includes actions taken for any reason.

2.4. Analytical Strategy

The model was tested using path analysis on raw weighted data using the EQS structural equation program (version 6.1) and the robust maximum likelihood (MLR) method of estimation to adjust for nonnormality. Because the derived model was saturated, the model was trimmed by excluding nonsignificant relationships and then reestimated, including covariance estimates between exogenous variables. Analyses were conducted with both weighted and unweighted samples to assess for potential inflation of error variances.[80] Findings for the two samples did not differ, suggesting that the use of weights did not attenuate results. Main results are reported using the weighted sample to represent the U.S. population as a whole except in the case of subsample analyses. Weights were not applied when we repeated the analysis by strata (geographic area and race/ethnic group).

The model was assessed for multicolinearity, nonlinearity, and heteroscedasticity to determine if basic regression assumptions could be met so that estimated model parameters would be unbiased.[81] It was determined that these assumptions were met.

3. RESULTS

The trimmed model that was estimated, excluding nonstatistically significant relationships, is presented in Fig. 2. Model fit indices (Satorra-Bentler scaled $\chi^2 = 8.58$, $df = 4$, $p = 0.07$; comparative fit index (CFI) = 0.998; root mean-square error of approximation (RMSEA) = 0.020, 90% CI: 0.000–0.039) indicated adequate fit for this model.[82–84] The estimated model parameters—path coefficients or betas (βs) and explained variances (R^2) for each equation estimated—are included. Descriptive statistics for model variables are presented in Table II. Finally, the zero-order correlation matrix for model variables is presented in Table III. Explained variances for each were 22% for knowledge, 6% for perceived effectiveness, 27% for milling, and 38% for preparedness action-taking.

3.1. The Effects of Preparedness Information Observed

The single strongest predictor of all in motivating household preparedness in America was

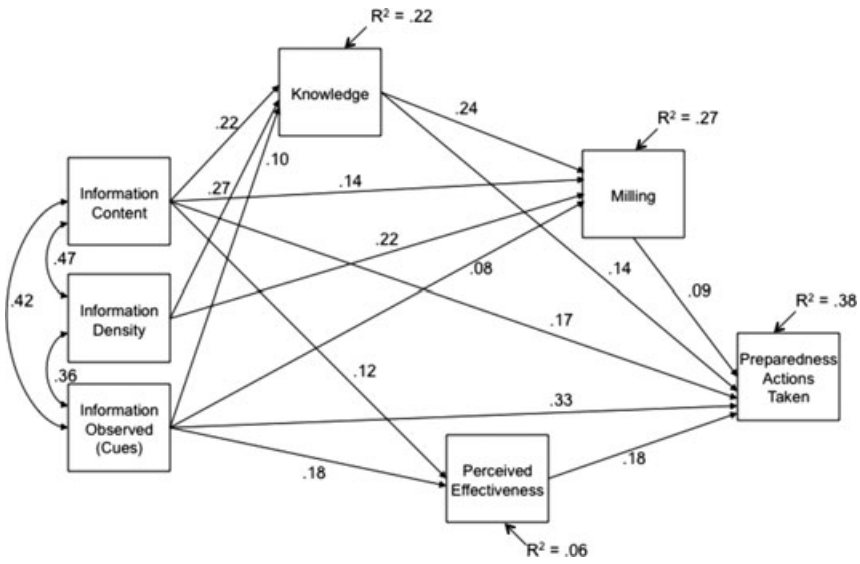

Fig. 2. Final estimated model. The weighted sample represents 2,811 individuals. Robust maximum likelihood estimation. Satorra-Bentler $\chi^2 = 8.58$, df $= 4$, $p = 0.07$; comparative fit index (CFI) $= 0.998$; root mean-square error of approximation (RMSEA) $= 0.020$ (90% confidence interval for RMSEA $=$ 0.000–0.039). Coefficients significant for all paths, $p < 0.001$; R^2 significant for all equations, $p < 0.001$. Standard errors for these relationships ranged from 0.01 to 0.06.

Table II. Descriptive Statistics (Weighted Sample)[a]

Variable	Mean	*SD*	No. of Items	α
Information Content (Sum, 0–4)[b]	2.0	1.4	4	0.72
Information Density (Sum, 0–6)[b]	3.2	1.8	3	0.73
Information Observed (Sum, 0–4)[b]	1.3	1.3	4	0.65
Knowledge (Mean, 1–5)[c]	2.4	1.0	8	0.92
Perceived Effectiveness (Mean, 1–5)[c]	3.3	1.0	4	0.75
Milling (Sum, 0–5)[b]	3.0	2.2	5	0.93
Proactive Risk Reduction (Sum, 0–4)[b]	1.2	1.3	4	0.64

[a]The weighted sample represents 2,811 individuals.
[b]Response format is "yes/no"; the percentage of "yes" responses is reported. Index scores were created by summing the number "yes" responses.
[c]Response format is a 5-point scale where 1 = "nothing" and 5 = "a lot" for knowledge, and 1 = "not at all effective" and 5 = "extremely effective" for perceived effectiveness.

preparedness actions observed. Its direct effect on preparedness actions taken was $\beta = 0.33$. Preparedness actions observed also had a relatively strong indirect effect on preparedness actions by increasing perceived effectiveness ($\beta = 0.18$), which, in turn, also predicted preparedness actions taken ($\beta = 0.18$). Moreover, this key role of preparedness information observed remained essentially the same when we conducted the same analyses on subsamples in the data set. This suggests—even though we have no statistical basis for generalizing to subsample populations—that this key path may apply to everyone (i.e., the different racial and ethnic minorities we examined) and everywhere (i.e., the different specific locations that we examined) in America. Preparedness actions observed had a relatively weaker, but statistically significant, effect on increasing knowledge about preparedness action to take ($\beta = 0.10$).

3.2. The Effects of Preparedness Information Received

As was the case with information observed, information received had both direct and indirect effects on motivating preparedness action-taking. Information received in terms of both content ($\beta = 0.22$) and density ($\beta = 0.27$) increased the knowledge that people have about the range of preparedness actions available to them to take, which, in turn, motivated ($\beta = 0.14$) taking preparedness actions. Moreover, content of preparedness information received ($\beta = 0.17$) also directly predicted household preparedness action-taking. Once again, an inspection of subsample estimates suggested that the key role of preparedness information received remained in place for the racial and ethnic minorities examined and also in the different geographical locations examined. Information content had a relatively weaker, but statistically significant, effect on perceived effectiveness of actions taken ($\beta = 0.12$), which in turn impacted preparedness action-taking as discussed.

3.3. The Mediating and Direct Effects of Milling

All remaining relationships in the model involve the many mediating and direct effect of milling on motivating preparedness action-taking. Four factors impacted milling: information content ($\beta = 0.14$), information density ($\beta = 0.22$), information observed ($\beta = 0.08$), and knowledge ($\beta = 0.24$). The subsequent direct effect of milling on preparedness actions actually taken was relatively weaker ($\beta = 0.09$).

Table III. Zero-Order Correlations (Weighted Sample)[a]

Model Variables	X_1	X_2	X_3	X_4	X_5	X_6	X_7
X_1 Content of preparedness information received	1.00						
X_2 Density of preparedness information received	0.47*	1.00					
X_3 Preparedness action information observed	0.42*	0.36*	1.00				
X_4 Knowledge of preparedness actions	0.38*	0.41*	0.29*	1.00			
X_5 Perceived effectiveness of preparedness actions	0.19*	0.12*	0.23*	0.10*	1.00		
X_6 Milling about preparedness actions	0.37*	0.42*	0.29*	0.41*	0.10*	1.00	
X_7 Preparedness actions taken	0.43*	0.31*	0.51*	0.35*	0.31*	0.32*	1.00

[a]The weighted sample represents 2,811 individuals.
*$p < 0.001$.

4. DISCUSSION

The estimated parameters of the model (see Fig. 2) reveal the relative success of the model at explaining preparedness knowledge, perceived effectiveness of preparedness actions, milling to discuss preparedness, and the ultimate endogenous variable of preparedness action-taking. Findings from the analysis confirm previous research and support communicating actionable risk in order to motivate household preparedness action-taking for high-consequence, low-probability terrorist, natural, and other hazard events. An inspection of the estimated model for the paths of greatest influence on motivating household preparedness actions reveals support for communicating actionable risk information in both theory and practice.

Stated simply, our findings indicate that households in America are most likely to take steps to prepare themselves if they observe the preparations taken by others, and these observations impact preparedness action-taking both directly, and also by leading observers to think the actions they are observing are effective because others have performed them. This set of causal paths suggests a more simple explanation than previously imagined, consistent with a diffusion of innovations explanation for how American households can be motivated to prepare.[25,26]

Our findings further indicate that information received from preparedness information providers also motivates American households to take actions to prepare both directly and indirectly, through knowledge—a finding that is consistent with both diffusion of innovations and communication theories.[25,26,29] This second key causal sequence reveals that providing preparedness information works if that information is *actionable* and is *dense* (from multiple sources and communicated over multiple channels).

4.1. The Case for Communicating Actionable Risk

We have presented what we conclude to be clear evidence for the practice of communicating actionable risk. The basic tenets of this perspective draw on both diffusion of innovations and communication theories, and they follow. First, people are strongly motivated to take action about risk when presented with information about the actions they could take. Second, actionable information takes two forms. These are information they obtain by observing others take actions to prepare, and verbal and written information they receive that describes those preparedness actions. Third, the former works to motivate preparedness in and of itself, but also by leading observers to conclude that preparedness actions are effective because others are taking them. Fourth, the latter works to motivate preparedness in and of itself, but also by working through increasing knowledge about what actions could actually be taken. Last, and perhaps most important, the emphasis of this perspective is to communicate *actions* rather than risk. The former would have people infer the potential for decreased personal disaster consequences in their future, whereas the latter would have people infer that preparedness actions are warranted. Communicating preparedness *actions* to motivate people to act is more direct than communicating *risk* and hoping that people will infer that they should take actions, and then, based on their inferences, act. This is a substantial departure from theoretical perspectives and program practices that seek primarily to communicate risk so that people might, then, infer that action-taking is warranted.

4.2. Contributions to Research and Theory

This research contributes in two ways to the accumulating body of research knowledge and theory on how public educational information motivates household preparedness behavior.

Our findings elevate the ability to generalize findings from other research on motivating household preparedness actions in two ways. This study was based on a statistically representative sample of all the households in the continental United States, and it confirmed many findings provided by previous studies that were performed on small populations in different and unique parts of the country. Examples include demonstrating the clear link between information factors such as density, content, and cues with preparedness action-taking. Our duplication of others' discoveries[42,44,46,85] affirms and lends enhanced external validity to their conclusions. Moreover, findings suggest that the communicating actionable risk model generalizes to different hazard types because: (1) we studied preparedness for *any* reason, and (2) our findings replicate those from prior hazard-specific research (e.g., earthquakes, floods, etc.).

Additionally, this research clearly identified general social processes that convert received preparedness information into actual household preparedness actions. These processes can be described as

follows. Actionable risk information received (density and content) and actionable risk information seen (cues) about preparedness actions are the key factors that motivate people to prepare. These factors have "direct" effects on increasing household preparedness that can be described as follows: the more people hear, read, and see about getting ready, the more they do to get ready. These same information factors also "indirectly" affect household preparedness through the now identified processes of increasing people's knowledge, the perceived effectiveness or efficacy of the preparedness actions they are considering, and by increasing discussions (milling) with others and seeking more information about preparedness actions before actually taking action. These intervening factors (knowledge, perceived effectiveness, and milling), in turn, also increase preparedness action-taking. In short, we have identified the processes by which public preparedness information is converted into public preparedness actions. These findings lend strong support for the utility of diffusion of innovations and communication theories for guiding public education campaigns designed to motivate individual and household preparedness for terrorism and other disasters.

4.3. Contributions to Practice

These conclusions are very good news. In the absence of an actual disaster (which is the strongest way, albeit *ex post facto*, to get people's attention and motivate preparedness actions), all three of the major information determinants of household preparedness are "pliable." Policies and programs can now confidently be developed that increase the substance and form of information dissemination in ways that will increase public preparedness action-taking. Our results are simple, but far-reaching. When the basic findings are examined, they seem intuitively obvious, and yet public education campaigns and other programs are typically not designed with these principles in mind. Our study yielded three key findings that can guide future practice.

First, our findings suggest that the strongest motivator of taking preparedness actions is when average people share what they have done to prepare with other individuals who have not done much. Thus, the most powerful preparedness spokespersons are not government agencies or nongovernment organizations (NGOs), but instead members of the public who have already prepared. This suggests that a key target group for preparedness information is not people who have *not* prepared, but people who already have; preparedness programs need to expand their current practice and entice such individuals to share what they have done with others.

Second, the findings suggest that programs to increase public preparedness should emphasize the actions people should take to become better prepared rather than the physical impacts of disasters, the science behind those impacts, and the magnitude of negative consequences that may ensue. Thus, public education campaigns and other programs should tell people about the preparedness behaviors they should take, how to take them, and how they can benefit from taking such actions. This means explaining how each action can cut future losses in the event of disaster.

Third, these findings indicate the importance of distributing dense information. Information is dense if information disseminators (all the information-providing partners) distribute consistent information over many different public communication channels, over time, and for the long-haul. Dense information is how programs can reach people through the background noise of everyday life. Some fear that the public will "tune out" repetitive messages. Our findings suggest the opposite; repetition is essentially the only way to help people "tune in."

4.4. Limitations

Ours was a large and complex research project. We invested most of the space on the questionnaire to measure many explanatory variables found in the published record across different disciplines that might bear on predicting household preparedness action-taking. Although we measured a wide range of actions that comprise the dependent variable of household preparedness, we were not able to measure those actions in full depth. Additionally, many other alternative explanations exist in the published record regarding factors that impact household preparedness action-taking (see Section 4.5). Our focus here was to develop and validate an information-to-action model, but this model has yet to be elaborated in terms of other factors that also influence household preparedness.

4.5. Future Research

We have several recommendations regarding future research. First, the model we tested should be validated on another sample. Second, future

research should expend much more questionnaire space than we did to measure in greater depth the range of specific actions that comprise the endogenous variable of household preparedness. Third, other research is needed to illustrate the impact of competing independent variable sets for household preparedness action-taking on the key variables, relationships, and social processes in the information-to-action model here reported. Alternative explanation variable sets include: (1) demographic factors,[44,68,69,86] (2) risk perception,[49,69,87–89] (3) perceptions about government and agencies,[36,90–93] (4) past experience,[68,94–97] and more. Fourth, an economic examination of the benefit-cost ratio of providing information to the public about preparedness actions is warranted. Fifth, research is needed to explore the milling construct in more depth and in new ways in light of the role that social media now plays as people seek and transmit information electronically. Understanding the process of electronic milling, or "eMilling," will greatly inform actionable risk communication as we have described it here. Finally, prior research[45,47,66] clearly concludes that a fourth exogenous information variable—information consistency across different messages—is an important predictor of preparedness action-taking. Even though we were not able to support this observation in this data set, we are uncomfortable suggesting that information consistency be excluded from either theory or practice based on our findings. We measured it with a single question while all other constructs were measured with multiple items. Future research should seek to demonstrate the role of information consistency in context of the variables we have reported as central to actionable risk communication.

ACKNOWLEDGMENTS

This research was supported by the U.S. Department of Homeland Security (DHS) through the National Consortium for the Study of Terrorism and Responses to Terrorism (START), grant number N00140510629 to the University of California at Los Angeles (UCLA); grant number SES-0647736 from the U.S. National Science Foundation to UCLA; and grant number 1543106 from the U.S. National Science Foundation to UCLA through the University of Colorado at Boulder. However, any opinions, findings, and conclusions or recommendations in this document are those of the authors and do not necessarily reflect views of the U.S. Department of Homeland Security, the U.S. National Science Foundation, or START. Field work was conducted by California Survey Research Services, Inc., under supervision of the UCLA Survey Research Center in the Department of General Internal Medicine. We thank William Marelich for helpful comments on an early draft of the article and Elizabeth Grandfield for assistance with data analysis. Finally, we acknowledge the reviewers of this article for their helpful comments.

REFERENCES

1. Wood MM, Kano M, Mileti DS, Bourque LB. Reconceptualizing household disaster readiness: The "Get Ready" pyramid. Journal of Emergency Management, 2009; 7(1): 25–37.
2. Needleman C. Ritualism in communicating risk information. Science, Technology, & Human Values, 1987; 12(3/4): 20–25.
3. Faulkner H, Ball D. Environmental hazards and risk communication. Environmental Hazards, 2007; 7(2):71–78.
4. CNN. U.S. deaths in Iraq, war on terror surpass 9/11 toll, September 3, 2006. Available at: http://edition.cnn.com/2006/WORLD/meast/09/03/death.toll/. Accessed on April 15, 2010.
5. Centers for Disease Control and Prevention. Assessment of health-related needs after tsunami and earthquake—Three districts, Aceh Province, Indonesia, July–August 2005. Morbidity and Mortality Weekly Report, 2006; 55(4):93–97.
6. Beven JL, II, Avila LA, Blake ES, Brown DP, Franklin JL, Knabb RD, Pasch RJ, Rhome FR, Stewart SR. Annual summary: Atlantic hurricane season of 2005. Monthly Weather Review (American Meteorological Society), 2008; 136(3):1131–1141.
7. United States Agency for International Development (USAID). Haiti Earthquake: Fact Sheet #52, Fiscal Year (FY) 2010, 2010. Available at: http://reliefweb.int/rw/RWFiles2010.nsf/FilesByRWDocUnidFilename/MUMA-85227Z-full_report.pdf/$File/full_report.pdf. Accessed on May 2, 2010.
8. U.S. Geological Survey. Magnitude 9.0—Near the east coast of Honshu, Japan, 2011, 2011. Available at: http://earthquake.usgs.gov/earthquakes/eqinthenews/2011/usc0001xgp/. Accessed on March 20, 2011.
9. Mileti DS. Disasters by Design: A Reassessment of Natural Hazards in the United States. Washington, DC: Joseph Henry Press, 1999.
10. De Marchi B. Not just a matter of knowledge: The Katrina debacle. Environmental Hazards, 2007; 7(2):141–149.
11. Federal Emergency Management Agency. FY 2010 Homeland Security Grant Program (HSGP), 2009. Available at: http://www.fema.gov/government/grant/hsgp/index.shtm. Accessed on April 15, 2010.
12. Althaus CE. A disciplinary perspective on the epistemological status of risk. Risk Analysis, 2005; 25(3):567–588.
13. Renn O. Concepts of risk: A classification. Pp. 53–82 in Krimsky S, Golding D (eds). Social Theories of Risk. Westport, CT: Praeger, 1992.
14. Plough A, Sheldon K. The emergence of risk communication studies: Social and political context. Science, Technology, & Human Values, 1987; 12(3/4):4–10.
15. National Cancer Institute. Theory at a Glance: A Guide for Health Promotion Practice. Washington, DC: U.S. Department of Health and Human Services, 2003.

16. Glanz K, Rimer BK, Lewis FM (eds). Health Behavior and Health Education: Theory, Research, and Practice (3rd edition). San Francisco, CA: Jossey-Bass, 2002.
17. Ajzen I. From intentions to actions: A theory of planned behavior. Pp. 11–39 in Kuhl J, Beckman J (eds). Action Control: From Cognition to Behavior. New York: Springer-Verlag, 1985.
18. Ajzen I, Madden TJ. Prediction of goal-directed behavior: Attitudes, intentions, and perceived behavioral control. Journal of Experimental Social Psychology, 1986; 22:453–474.
19. Janz NK, Becker MH. The health belief model: A decade later. Health Education Quarterly, 1984; 11:1–47.
20. Rosenstock IM. Historical origins of the health belief model. Health Education Monographs, 1974; 2:328–335.
21. Rogers RW. A protection motivation theory of fear appeals and attitude change. Journal of Psychology, 1975; 91: 93–114.
22. Rogers RW. Cognitive and physiological processes in fear appeals and attitude change: A revised theory of protection motivation. Pp. 153–176 in Cacioppo JT, Petty RE (eds). Social Psychophysiology: A Sourcebook. New York: Guilford Press, 1983.
23. Bandura A. Self Efficacy, the Exercise of Control. New York: W. H. Freeman, 1997.
24. Minkler M, Wallerstein NB. Improving health though community organization and community building. Pp. 279–311 in Glanz K, Rimer BK, Lewis FM (eds). Health Behavior and Health Education: Theory, Research, and Practice (3rd edition) San Francisco, CA: Jossey-Bass, 2002.
25. Oldenburg B, Parcel GS. Diffusion of innovations. Pp. 312–334 in Glanz K, Rimer BK, Lewis FM (eds). Health Behavior and Health Education: Theory, Research, and Practice (3rd edition). San Francisco, CA: Jossey-Bass, 2002.
26. Parcel GS, Perry CI, Taylor WC. Beyond demonstration: Diffusion of health promotion innovations. Pp. 229–251 in Bracht N (ed). Health Promotion at the Community Level. Newbury Park, CA: Sage, 1990.
27. Rogers EM. Diffusion of Innovations (5th edition). New York: Free Press, 2003.
28. Rogers EM. A prospective and retrospective look at the diffusion model. Journal of Health Communication, 2004; 9:13–19.
29. Finnegan JR, Jr., Viswanath K. Communication theory and health behavior change. Pp. 361–388. in Glanz K, Rimer BK, Lewis FM (eds). Health Behavior and Health Education: Theory, Research, and Practice (3rd edition). San Francisco, CA: Jossey-Bass, 2002.
30. McGuire WJ. Public communication as a strategy for inducing health-promoting behavioral change. Preventive Medicine, 1984; 13(3):299–313.
31. Hornik RC (ed). Public Health Communication: Evidence for Behavior Change. Mahwah, NJ: Lawrence Erlbaum Associates, 2002.
32. Lasswell HD. The structure and function of communication in society. Pp. 37–51 in Bryson L (ed). The Communication of Ideas. New York: Institute for Religious and Social Studies, 1948.
33. McGuire WJ. Theoretical foundations of campaigns. Pp. 41–70 in Rice RE, Atkins C (eds). Public Communication Campaigns. Thousand Oaks, CA: Sage, 1989.
34. Covello VT, Slovic P, von Winterfeldt D. Risk communication: A review of the literature. Risk Abstracts, 1986; 3(4):172–182.
35. Covello VT, Mumpower J. Risk analysis and risk management: An historical perspective. Risk Analysis, 1985; 5(2):103–120.
36. Johnson BB. Accounting for the social context of risk communication. Science & Technology Studies, 1987; 5(3/4): 103–111.
37. Bier VM. On the state of the art: Risk communication to the public. Reliability Engineering & System Safety, 2001; 71(2):139–150.
38. Kasperson RE. Six propositions on public participation and their relevance for risk communication. Risk Analysis, 1986; 6(3):275–281.
39. Haas JE, Trainer P (eds). Effectiveness of the tsunami warning system in selected coastal towns in Alaska. Fifth World Conference on Earthquake Engineering; 1974; Rome, Italy.
40. Waterstone M. Hazard mitigation behavior of flood plain residents, Working Paper No. 35. Boulder, CO: Natural Hazards Center, Institute of Behavioral Science, University of Colorado, 1978.
41. Ruch C, Christensen L. Hurricane Message Enhancement. College Station, TX: Texas Sea Grant College Program, Texas A & M University, 1980.
42. Mileti DS, Hutton JR, Sorensen JH. Earthquake Prediction Response and Options for Public Policy. Boulder, CO: Institute of Behavioral Sciences, University of Colorado, 1981.
43. Turner RH, Nigg JM, Heller-Paz D. Waiting for Disaster. Los Angeles, CA: University of California Press, 1986.
44. Mileti DS, O'Brien PW. Warnings during disaster: Normalizing communicated risk. Social Problems, 1992; 39(1):40–57.
45. Mileti DS, Darlington JD. The role of searching in shaping reactions to earthquake risk information. Social Problems, 1997; 44(1):89–103.
46. Farley JE, Barlow HD, Finkelstein MS, Riley L. Earthquake hysteria, before and after: A survey and follow-up on public response to the Browning forecast. International Journal of Mass Emergencies and Disasters, 1993; 11:305–322.
47. Mileti DS, Fitzpatrick C. The causal sequence of risk communication in the Parkfield earthquake prediction experiment. Risk Analysis, 1992; 12(3):393–400.
48. Haas J, Mileti D. Earthquake prediction and other adjustments to earthquakes. Bulletin of the New Zealand Society for Earthquake Engineering, 1976; 9(4):183–194.
49. Eisenman DP, Glik D, Ong M, Zhou Q, Tseng C-H, Long A, Fielding J, Asch S. Terrorism-related fear and avoidance behavior in a multiethnic urban population. American Journal of Public Health, 2009; 99(1):168–174.
50. Burton I, Kates RW, White GF. The Environment as Hazard (2nd edition). New York: Guilford Press, 1993.
51. Weinstein ND. Effects of personal experience on self-protective behavior. Psychological Bulletin, 1989; 105(1):31–50.
52. Sims JH, Bauman DD. Educational programs and human response to natural hazards. Environment and Behavior, 1983; 15:165–189.
53. Weaver SC. Mathematical Theory of Communication. Urbana: University of Illinois Press, 1949.
54. Drabek TE, Boggs KS. Families in disaster: Reactions and relatives. Journal of Marriage and the Family, 1968; 30(3):443–51.
55. Greene M, Perry R, Lindell M. The March 1980 eruptions of Mt. St. Helens: Citizen perceptions of volcano threat. Disasters, 1981; 5(1):49–66.
56. Smith VK, Desvousges WH, Payne JW. Do risk information programs promote mitigating behavior? Journal of Risk and Uncertainty, 1995; 10(3):203–221.
57. Quarantelli EL. Perception and reactions to emergency warnings of sudden hazards. Ekistics, 1984; 309: 511–515.
58. Dynes RR, Purcell AH, Wenger DE, Stern PE, Stallings RA, Johnson QT. Report to the Emergency Preparedness and Response Task Force from Staff Report to the President's Commission on the Accident at Three Mile Island. Washington, DC: President's Commission on the Accident at Three Mile Island, 1979.
59. Basolo V, Steinberg LJ, Burby RJ, Levine J, Cruz AM, Huang C. The effects of confidence in government and information

on perceived and actual preparedness for disasters. Environment and Behavior, 2009; 41(3):338–364.
60. Turner RJ, Paz DH, Young B. Community Response to Earthquake Threat in Southern California. Parts 4–6 and 10. Los Angeles, CA: University of California, 1981.
61. Mileti DS, Fitzpatrick C, Farhar BC. Lessons from the Parkfield earthquake prediction. Environment, 1992; 34:16–39.
62. Rogers GO. Human Components of Emergency Warnings. Pittsburg, PA: Center for Social and Urban Research, University of Pittsburg, 1985.
63. Turner RH, Nigg JM, Paz DH, Young BS. Earthquake threat: The humanitarian response in Southern California Los Angeles: Institute for Social Science Research, University of California, 1979.
64. Turner RH. Waiting for disaster: Changing reactions to earthquake forecasts in southern California. International Journal of Mass Emergencies and Disasters, 1983; 1:307–334.
65. Mikami S, Ikeda K. Human response to disasters. International Journal of Mass Emergencies and Disasters, 1985; 3: 107–132.
66. Mileti DS, O'Brien PW. Public response to aftershock warnings. In U.S. Department of the Interior, editor. Washington, DC: Geological Survey, 1993.
67. Mileti DS, Fitzpatrick C. Great Earthquake Experiment: Risk Communication and Public Actions. Boulder, CO: Westview Press, 1993.
68. Russell LA, Goltz JD, Bourque LB. Preparedness and hazard mitigation actions before and after two earthquakes. Environment and Behavior, 1995; 27(6):744–770.
69. Lindell MK, Whitney DJ. Correlates of household seismic hazard adjustment adoption. Risk Analysis, 2000; 20(1): 13–25.
70. McGuire WJ. Theoretical foundations of campaigns. In Rice R, Paisley W (eds). Public Communication Campaigns. Beverly Hills, CA: Sage, 1981.
71. Norris FH. Frequency and structure of precautionary behavior in the domains of hazard preparedness, crime prevention, vehicular safety, and health maintenance. Health Psychology, 1997; 16(6):566–575.
72. Palm R, Hodgson M, Blanchard R, Lyons D. Earthquake Insurance in California. Boulder, CO: Westview, 1990.
73. Mulilis J, Duval TS. Negative threat appeals and earthquake preparedness: A person-relative-to-event (PrE) model of coping with threat. Journal of Applied Social Psychology, 1995; 25(15):1319–1339.
74. Weinstein ND, Nicolich M. Correct and incorrect interpretations of correlations between risk perceptions and risk behaviors. Health Psychology, 1993; 12(3):235–245.
75. Turner RH, Killian LM. Collective Behavior (3rd edition) Englewood Cliffs, NJ: Prentice-Hall, 1987.
76. Ball-Rokeach SJ. From pervasive ambiguity to a definition of the situation. Sociometry, 1973; 36(3):378–389.
77. Oldendick RW, Bishop GF, Sorenson SB, Tuchfarber AJ. A comparison of the Kish and last-birthday methods of respondent selection in telephone surveys. Journal of Official Statistics, 1988; 4:307–318.
78. The American Association of Public Opinion Research (AAPOR). Standard definitions: Final dispositions of case codes and outcome rates for surveys; 2009.
79. Cronbach LJ. Coefficient alpha and the internal structure of tests. Psychometrika, 1951; 16:297–333.
80. Korn EL, Graubard BI. Analysis of large health surveys: Accounting for the sampling design. Journal of the Royal Statistical Society Series A (Statistics in Society), 1995; 158(2):263–295.
81. Berry WD, Feldman S. Multiple Regression in Practice, Monograph No. 50. New York: Sage Publications, 1985.
82. Satorra A. Scaled and adjusted restricted tests in multisample analysis of moment structures. Pp. 233–247 in Heijmans RDH, PDS G, Statorra A (eds). Innovation in Multivariate Statistical Analysis. London: Kluwer Academic Publishers, 2000.
83. Hu L-T, Bentler PM. Cutoff criteria for fit indices in covariance structure analysis: Conventional criteria for fit indices in covariance structure analysis: Conventional criteria versus new alternatives. Structure Equation Modeling, 1999; 6: 1–55.
84. Brown MW, Cudeck R. Alternative ways of assessing model fit. Pp. 136–162 in Bollen KA, Long JS (eds). Testing Structural Equation Models. Newbury Park, CA: Sage, 1993.
85. Mileti DS, Nigg JM. Earthquakes and human behavior. Earthquake Spectra, 1984; 1(1):89–106.
86. Phillips BD, Metz WC, Nieves LA. Disaster threat: Preparedness and potential response of the lowest income quartile. Global Environmental Change Part B: Environmental Hazards, 2005; 6(3):123–133.
87. Drabek TE. Social processes in disaster: Family evacuation. Social Problems, 1969; 16(3):336–348.
88. Mileti DS. Natural Hazard Warning Systems in the United Staes: A Reserach Assessment. Boulder, CO: Institute of Behavioral Science, University of Colorado, 1975.
89. Slovic P. Perception of risk. Science, 1987; 236(4799):280–285.
90. Frewer L. The public and effective risk communication. Toxicology Letters, 2004; 149(1–3):391–397.
91. Palenchar MJ, Heath RL. Strategic risk communication: Adding value to society. Public Relations Review, 2007; 33(2):120–129.
92. Trumbo CW, McComas KA. The function of credibility in information processing for risk perception. Risk Analysis, 2003; 23(2):343–353.
93. Slovic P. Perceived risk, trust and democracy. Pp. 316–326 in Slovic P (ed). The Perception of Risk. London: Earthscan Publications, 2000.
94. Siegel JM, Shoaf KI, Afifi AA, Bourque LB. Surviving two disasters: Does reaction to the first predict response to the second? Environment and Behavior, 2003; 35(5): 637–654.
95. Nguyen LH, Shen H, Ershoff D, Afifi AA, Bourque LB. Exploring the causal relationship between exposure to the 1994 Northridge earthquake and pre- and post-earthquake preparedness activities. Earthquake Spectra, 2006; 22(3):569–587.
96. Lindell MK, Perry RW. Household adjustment to earthquake hazard: A review of research. Environment and Behavior, 2000; 32(4):461–501.
97. Dooley D, Catalano R, Mishra S, Serxner S. Earthquake preparedness: Predictors in a community survey. Journal of Applied Social Psychology, 1992; 22(6):451–470.