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Linking the Heuristic-Systematic Model and Depth of Processing

This study draws a nexus between heuristic-systematic information processing and the theory of planned behavior through a model of risk information seeking and processing. The model proposes that the form of information processing individuals apply to risk information from the media and other sources affects beliefs, evaluations, and attitudes considered important to making judgments about performing risk-reducing behaviors. This study found that deeper, more systematic processing of risk information is positively related to evaluation strength, attitude strength, and the number of strongly held behavioral beliefs actively considered by respondents when thinking about environmental hazards. The relationships were consistent, appearing across two communities and three risks (two health risks and one ecological risk), and held up under multiple statistical controls.

Risk communication campaigns usually are designed to encourage persons to develop changes in risk-related behaviors. In pursuit of this goal, researchers typically employ risk information (e.g., a message) as an independent variable and evaluate the effect of the stimulus on individuals' attitudes and behavior. Inherent in this approach is the assumption that information does something to individuals. If one can illuminate that causal process, goes the argument, one can then design message interventions that will cause people to buckle their seatbelts, recycle, or adopt low-fat diets. However, this top-down, sender-oriented approach runs counter to suggestions by many risk perception researchers that risk communication scholars should consider receiver-oriented, bottom-up approaches (see e.g., Juanillo & Scherer, 1995; Krimsky & Plough, 1988; National Research Council, 1989) that place an

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emphasis on the individual as a consumer of information and one who can become engaged intellectually with the risk issue at hand. Instead of just asking how messages may influence people, this receiver-oriented approach calls for a focus on understanding individual variation in the evaluative behaviors of the information user.

In this study we evaluate the notion that systematic (i.e., deeper and more cognitively energetic) processing of health and environmental risk information leads individuals (a) to adhere to a greater number of strongly held relevant beliefs about a hazard, (b) to become more polarized in their evaluations when deciding what to do personally about a hazard, and (c) to become more polarized in their attitudes toward the hazard.

A model (Griffin, Dunwoody, & Neuwirth, 1999) of risk information seeking and processing (RISP) serves as the conceptual framework underlying these basic ideas. The RISP model synthesizes components of two prominent models: Eagly and Chaiken's (1993) heuristic-systematic model (HSM) of information processing and Ajzen's theory of planned behavior (Ajzen, 1988; Ajzen & Fishbein, 1980; Fishbein & Ajzen, 1975). The former helps researchers understand how people come to seek, attend to, and process information about a given risk, and the latter helps scholars discern how those communication behaviors may influence beliefs, evaluations, attitudes, and ultimately, the adoption and maintenance of preventive behaviors. Aspects of the RISP model relevant to the present study are discussed in the following.

HSM and Information Processing

People might process information about hazards intensively, superficially, or not at all. The RISP model accounts for these variations by incorporating mechanisms found in Eagly and Chaiken's (1993) heuristic-systematic model. In particular, the HSM formulation stipulates that a person's desire for accurate and sufficient information is a strong motivation for processing. This sufficiency principle, stated Eagly and Chaiken, "asserts that people will exert whatever effort is required to attain a 'sufficient' degree of confidence that they have accomplished their processing goals" (p. 330). Whether processing goals—and corresponding levels of confidence that one has sufficient information—are set high or low influences one of two processing modalities: heuristic and systematic.

Eagly and Chaiken (1993) defined heuristic processing as "a limited mode of information processing that requires less cognitive effort and fewer cognitive resources" (p. 327) than systematic processing. By default, most people employ the principle of least effort by processing messages heuristically, judging their validity and making decisions to comply through the use of

superficial cues such as the length of the message, the use of a trusted spokesperson, or the use of statistical data. Systematic processing, by comparison, involves a much more comprehensive effort to analyze and understand information. However, whereas systematic processing involves the careful and extensive evaluation of information, heuristic processing entails the use of simple decision rules (e.g., the more arguments, the better) to form a judgment. Consequently, attitudes based on systematic processing tend to be more permanent, whereas attitudes based on heuristic processing are relatively more volatile. Both forms of processing, however, can take place simultaneously (Eagly & Chaiken, 1993) as people process information to the point they regard as sufficient.

The RISP formulation proposes that an "information sufficiency" gap between what someone knows and what he or she needs to know about a hazard motivates a person to devote more cognitive effort to the systematic processing of messages about the hazard and behavior related to it, for example, evaluating the message critically, thinking about the message, and integrating message-based information with what one already knows. However, systematic processing not only depends on one's capacity to think comparatively and critically but also on (a) one's existing knowledge structures (e.g., education), (b) the perceived ability to obtain relevant information (Eagly & Chaiken, 1993), and (c) the perceived usefulness and credibility of available information.

Previous tests of the RISP model have found that information sufficiency is related to affective response to the risk and perceived normative pressures (Griffin, Neuwirth, & Dunwoody, 1998) as well as appearing to influence the seeking, avoidance, and heuristic or systematic processing of risk information (Griffin, Dunwoody, Neuwirth, & Giese, 1999; Trumbo, 1999, 2002).

Theory of Planned Behavior

In extending the implications of the RISP model to the realms of behavior, we utilize Ajzen's (1988) theory of planned behavior (TPB). The theory has been repeatedly tested across a wide range of human actions, including responses to health risks of various kinds (e.g., Boyd & Wandersman, 1991; Fishbein & Middlestadt, 1989; Griffin, Neuwirth, & Dunwoody, 1995; Henning & Knowles, 1990; Knuth, Connelly, & Shapiro, 1993; Montano & Taplin, 1991; Stasson & Fishbein, 1990).

In brief, the theory of planned behavior suggests that a given behavior (B) is predicted by behavioral intention (BI) and perceived behavioral control (PBC). Also predicting BI are PBC, attitude toward the behavior (AAct), and subjective norms (SN). Antecedent to AAct is cognitive structure—sometimes

termed *indirect* or *belief-based* attitude—a variable that is composed of a set of up to half a dozen or so salient behavioral beliefs (*b*), typically about the outcome of performing a specific behavior, and an evaluation (*e*) (e.g., the goodness or badness) of each belief outcome (Ajzen, 1991; Fishbein & Ajzen, 1975). The relationship of central interest examined in the present study is between risk information processing behavior and the components related to cognitive structure in TPB—beliefs and evaluations.

The Link Between Information Processing and Cognitive Structure

In their discussion of processing modalities as antecedents to attitudes, Ajzen and Sexton (1999) stated that systematic processing, unlike heuristic processing, varies along a continuum of depth:

> The depth-of-processing dimension is of importance for our purposes because it speaks to the domain of beliefs that become accessible in a given context. Clearly, the number of accessible beliefs is likely to increase with processing depth, and *the strength and evaluative implications* (emphasis added) of accessible beliefs may also change as a result of continued deliberation. (pp. 122-123)

Processing depth is understood as the degree to which information receives semantic elaboration (Craik & Tulving, 1975). Belief accessibility entails the set of beliefs actively considered or attended to when considering a topic (Ajzen & Sexton, 1999), and belief strength is considered to be the perceived likelihood that a belief is associated with an attribute (Fishbein & Ajzen, 1975).

Elsewhere (Eagly & Chaiken, 1993) it has been noted that, in general, attitudes developed through a more intense form (i.e., systematic) of processing are stronger and more intensely held than those developed through superficial (i.e., heuristic) processing. Thus, in examining beliefs and evaluations as precursors of attitudes, we would expect further that the strength of cognitive structure, a composite (belief-by-evaluation) measure of "belief-based" attitude (Ajzen, 1991; Ajzen & Driver, 1992), also would demonstrate a positive relationship with depth of processing. Cognitive structure is considered a hierarchical system of beliefs and associated evaluations about an object or issue (Fishbein & Ajzen, 1975).

These propositions lead to the central premise tested in this study: Systematic processing will be positively related to the degree to which people actively consider salient beliefs about a hazard—their depth of processing. In

particular, our study (a) measures systematic processing along a continuum that includes self-report measures of careful, deliberative, and comparative thinking; (b) specifically assesses the number of behavioral beliefs individuals strongly endorse (i.e., salient beliefs) when deciding about a risk-reduction behavior; and (c) assesses the strength of evaluations and attitudes associated with these beliefs. These research expectations are formalized next.

Research Question and Hypotheses

The guiding research question is: What is the relationship of heuristic and systematic processing of risk information to (a) the number of behavioral beliefs about a risk-related behavior that an individual holds strongly, (b) his or her evaluations of the outcomes of that behavior, and (c) his or her cognitive structure with regard to performing that behavior? Specifically, we expect that:

Hypothesis 1: Greater use of systematic processing will be positively related to the:

Hypothesis 1a: number of strongly held behavioral beliefs associated with the performance of a behavior;
Hypothesis 1b: strength of evaluation associated with behavioral beliefs; and
Hypothesis 1c: strength of cognitive structure (indirect attitude) toward the behavior.

Hypothesis 2: Greater use of heuristic processing will be negatively related to the:

Hypothesis 2a: number of strongly held behavioral beliefs associated with the performance of a behavior;
Hypothesis 2b: strength of evaluation associated with behavioral beliefs; and
Hypothesis 2c: strength of cognitive structure (indirect attitude) toward the behavior.

Method

Study Context

The overall purpose of the study is to test elements of the model of risk information seeking and processing using three health and environmental risks across two different metropolitan areas on the shores of the Great Lakes: Milwaukee, WI, on Lake Michigan, and Cleveland, OH, on Lake Erie. The current analysis examines parts of the HSM and TPB models, specifically, two

conjunctions between them: the relationship of information processing (from RISP) to the strength of salient attributes brought to bear on a risk-related decision (applying TPB) and the strength of evaluations and attitudes associated with these attributes. Two of the risks being examined entail potential for harm to personal health: eating Great Lakes fish and drinking tap water drawn from the Great Lakes. The third risk is environmental, specifically, threats to the health of the Great Lakes ecosystem.

Fish in the Great Lakes, similar to fish from other waters, can contain various chemicals, most notably polychlorinated biphenyls (PCBs). Human consumption of PCB-laden fish is a suspected cancer risk and has been associated with developmental problems in infants whose mothers had regularly eaten PCB-contaminated fish. Every year for the past quarter century, states surrounding the Great Lakes, including Wisconsin and Ohio, have issued advisories that warn people to avoid or limit consumption of certain sizes and varieties of fish and that suggest ways to prepare the fish to reduce exposure to chemical contamination. This information is available in pamphlets, sometimes in news media, and potentially via other sources as well.

The second health risk of concern, potential hazards lurking in municipal drinking water, is of course not limited to the Great Lakes. Municipal drinking water can contain substances such as chemicals and lead as well as organisms that occasionally slip past municipal water treatment systems. In recent years, the United States has seen an increase in major outbreaks of various waterborne illnesses. Probably the most notable outbreak took place in 1993 in Milwaukee, one of the communities in this study. A tiny parasite, cryptosporidium, entered the city drinking water from Lake Michigan and produced the largest recorded outbreak of waterborne disease in the nation's history. Milwaukee has since installed special monitoring and treatment equipment. Nonetheless, cryptosporidium is difficult and expensive to detect and purge from municipal water systems and could potentially strike somewhere again. Thus, the study includes an examination of people's responses to potential hazards from waterborne parasites.

The RISP model was primarily developed to help researchers examine individuals' responses to personal health risks. However, it is likely that many of the same processes described in the RISP model might also apply to individuals' responses to risks to the health of the natural environment. Thus, the last risk studied concerns threats to the health of the Great Lakes ecosystem. The cumulative effects of dangerous emissions from industry, power plants, automobile exhausts, and runoff from cities and farms has resulted in increased concentrations of toxins such as mercury, lead, dioxin, mirex, and toxaphene. Along with posing a broad risk to the health of human

and nonhuman organisms, these pollutants have the effect of decreasing aesthetics and recreational opportunities.

Design, Sampling, and Interviewing

The data in this analysis are drawn from the second wave of a panel design study conducted in Milwaukee and Cleveland. These two medium-sized American cities have experienced increases in concentrations of pollutants in the fish, water, and sediments in the lake. Both cities also draw their drinking water from the lakes and have relatively ready access to commercially caught and sport-caught fish from the lakes.

From October 1996 to March 1997, the Wisconsin Survey Research Laboratory (WSRL), a professional research organization associated with the University of Wisconsin-Extension, conducted a telephone sample survey of 1,123 adult residents of the two metropolitan areas (579 in Milwaukee and 544 in Cleveland). The combined response rate was 55.2% (61.3% in Milwaukee and 50% in Cleveland). Residences were contacted using random digit dialing and respondents were chosen randomly within households. From October 1997 through March 1998, WSRL successfully reinterviewed 716 (63.8%) of the respondents from the previous year (376 in Milwaukee and 340 in Cleveland). As a control for sensitization in the panel, 171 new respondents were interviewed for the second wave using the same procedures as were used to select respondents for the first wave, for a total *N* of 887 in the second wave (441 in Milwaukee and 446 in Cleveland). Due to cost constraints, TPB variables were not added to the questionnaire until the second wave, and thus the second wave data are used in this analysis.[2]

At the start of the first wave interview, respondents were asked about one of the three topics involving a hazard; new respondents in the second wave were similarly assigned topics. The first topic was comprised of questions covering fish consumption risks (fish hazard), one topic concerned the tap water risks (tap water hazard), and the third topic explored was composed of questions about risks to the Great Lakes ecosystem (ecosystem hazard). Most questions covering tap water and ecosystem hazards were identical in construction to questions about fish. This parallel construction was designed to allow meta-testing of the model by combining data across risks as much as possible. To minimize potential order effects, survey questions within a battery of questions with similar scales (e.g., 5-point, Likert-type, agreement scale) were presented to respondents starting from a random point in the set.

In applying the model to possible hazards of fish consumption, the interviewers' first questions were designed to net respondents for whom eating

Great Lakes fish was a relevant personal matter. Respondents were asked about fish consumption generally, if they had eaten a meal of Great Lakes fish that year, or if they had made a decision to avoid these fish specifically because of health concerns. Respondents who ate or intentionally refrained from eating Great Lakes fish were questioned about fish. Respondents to whom fish consumption was not a relevant topic were randomly assigned to one of the other hazard topics. In all, 528 respondents were questioned about fish in the second wave (260 in Milwaukee, 268 in Cleveland), 204 were asked about tap water (111 in Milwaukee, 93 in Cleveland), and 155 provided their views about the lake ecosystem (70 in Milwaukee, 85 in Cleveland). Of the respondents, 716 had been interviewed a year earlier, and 171 interviews were with new respondents. Interviews took approximately 27 minutes each, and all applicable human subjects and informed consent practices were followed throughout the study.

Questionnaire Development

To aid in the development of the questionnaire, the WSRL conducted four focus groups with a random sample of Milwaukee-area residents in the spring of 1996. The focus groups were designed to gather information about various components of RISP and TPB that needed some exploratory investigation, including participants' self-reports of information processing activities (based on a stimulus article presented in the focus group) and relevant, salient behavioral beliefs. Information from the focus group analyses was used to help prepare draft questionnaires distributed to a convenience sample of students at the researchers' three universities in the summers of 1996 and 1997. Combined, these questionnaires operationalized all of the models' components across a variety of risks. Item and scale analyses, conducted primarily by combining the data across risks and universities, yielded the measures used in the actual survey. The WSRL then conducted telephone pretests of the resulting questionnaire with random samples of Milwaukee- and Cleveland-area residents before actual interviews began each year.

Measurement

Control Variables

Statistical controls included demographic variables, panel sensitization, perceived information gathering capacity, information sufficiency, and attention to the topic.

Six demographic variables were used in this study as control variables. These are education (measured as educational achievement ranging from grade school to postgraduate), annual household income (Griffin, 1990; Olien, Donohue, & Tichenor, 1983), age (Fischer, Morgan, Fischoff, Nair, & Lave, 1991; Griffin & Dunwoody, 2000), ethnicity (whether the person is a member of a minority group), and gender (Flynn, Slovic, & Mertz, 1994; Vaughan & Nordenstam, 1991). Descriptive statistics are as follows: education ($M = 5.37$, $SD = 1.99$ on a 1- to 8-point scale), household income ($M = 45.33$, $SD = 35.10$), age ($M = 49.05$, $SD = 15.95$), gender (55% women), and minority status (19.7% minority). The respondent's community—Milwaukee (coded as 1) or Cleveland (2)—also was included as a control variable. Panel sensitization was measured as whether (1) or not (0) the respondent had also been interviewed for the study during the first wave.

Independent Variables: Risk Information Processing

The RISP model includes aspects of information processing (heuristic and systematic) that are a part of the HSM formulation.

Heuristic processing is a mode of processing that is less effortful and uses fewer cognitive resources (Eagly & Chaiken, 1993). Four questionnaire items measured heuristic processing of risk information. Respondents indicated via 5-point, Likert-type scales their agreement or disagreement with the following statements that they were told represented different ways that people personally deal with information that they run across in the mass media and other places about the given risk: "When I encounter information about this topic, I focus on only a few key points;" "If I have to act on this matter, the advice of one expert is good enough for me;" "When I see or hear information about this topic, I rarely spend much time thinking about it;" and "There is far more information on this topic than I personally need." Greater agreement represented a general pattern of heuristic processing of the relevant information.

Based on work by various authors (e.g., Eveland, 2001; Griffin, Dunwoody, & Zabala, 1998; Kosicki & McLeod, 1990; Perse, 1990a, 1990b, 1990c; Sotirovic & McLeod, 2001), five items were similarly used to measure systematic processing of risk information. These were: "After I encounter information about this topic, I am likely to stop and think about it;" "If I need to act on this matter, the more viewpoints I get the better;" "It is important for me to interpret information about this topic in a way that applies directly to my life;" "After thinking about this topic, I have a broader understanding;" and "When I encounter information about this topic, I read or listen to most of it, even though I may

not agree with its perspective." The third and fourth items in particular should represent deeper processing (e.g., drawing inferences and relationships to what is already known), and so depth of processing is included in the operational definition of systematic processing employed in this study. Greater agreement with all the items represented a general pattern of systematic processing of the relevant topic information.

The four heuristic processing and five systematic processing items were subjected to a factor analysis (oblique rotation) that produced the two distinct factors in Table 1. Weighted factor scores were used to construct indices of systematic (five items, omega = .69) and heuristic processing (four items, omega = .68). See Carmines and Zeller (1979) for a discussion of omega as a reliability coefficient.[3] The factor score weights used were derived from a pool of observations from all respondents across all waves of the larger study (n = 2,470) and used to weight observations in each of the study's waves.[4]

RISP Control Variables

Information sufficiency and capacity, channel beliefs, and measures of attention to the topic were included as control variables because of their proximity to information processing measures in the RISP Model.

Perceived information gathering capacity (PIGC). PIGC was the sum of two items (M = 6.03, SD = 1.68, alpha = .58) that asked individuals to respond on 5-point, Likert-type scales to the statements: "If I wanted to, I could easily get all the information I need about this topic" and "It is hard for me to get useful information about this topic" (reverse coded).

Information sufficiency. Information sufficiency was represented in the analysis by two separate self-report variables measured on 0 to 100 scales: (a) current knowledge about the risk (M = 37.51, SD = 23.47) and (b) the information sufficiency threshold (M = 66.20, SD = 22.99), that is, the amount of knowledge they would need to deal adequately with the risk (fish and tap water hazards) or to achieve an understanding of threats to the health of local Great Lake that is good enough for their purposes (ecosystem hazard).

Channel beliefs. Beliefs about channels of risk information, including their trustworthiness and usefulness, have the potential to influence the information seeking and processing strategies people employ. Focus groups and a review of the literature on media belief schemas (Fredin & Kosicki, 1989; Fredin, Kosicki, & Becker, 1996; Fredin, Monnett, & Kosicki, 1994; Fredin & Tabaczynski, 1993; Kosicki, Becker, & Fredin, 1994; Kosicki & McLeod, 1990)

Table 1
Factor Analysis of Systematic and Heuristic Risk Information Processing Items

Item	Factor Loadings	
	Factor 1 Systematic Processing	Factor 2 Heuristic Processing
After I encounter information about this topic, I am likely to stop and think about it.	.59	–.14
If I need to act on this matter, the more viewpoints I get the better.	.50	–.12
After thinking about this topic, I have a broader understanding.	.49	.11
When I encounter information about this topic, I read or listen to most of it, even though I may not agree with its perspective.	.42	–.09
It is important for me to interpret information about this topic in a way that applies directly to my life.	.41	–.01
When I encounter information about this topic, I focus on only a few key points.	.11	.56
There is far more information on this topic than I personally need.	–.11	.48
When I see or hear information about this topic, I rarely spend much time thinking about it.	–.21	.43
If I need to act on this matter, the advice of one expert is enough for me.	–.06	.41
Sum of squared loadings	1.93	0.43
Percentage of variance	21.4	4.7

Note. Principal axis factoring procedure. Oblique rotation. Factor correlation = –.48.

generated six specific beliefs about the general functioning of the mass media thought to be related to processing strategies (see Appendix). Respondents were asked the extent to which they agreed or disagreed (5-point Likert scales) with each belief, and factor analysis was used to create two composite indices for inclusion in subsequent analysis.

The first factor, labeled *Media Distort*, reflects beliefs about media attributes focusing on bias, exaggeration, sensationalization, and coverage of unconnected events, omega = .72. The second factor, a three-item index called *Validity Cues*, reveals a focus on patterns of media content thought to provide cues about the validity of information received, omega = .60. See Appendix for

exact wording. Although lower than desirable, the reliabilities are similar to figures (alpha = .69) reported elsewhere (Fredin et al., 1994).

Media Attention

A long-standing staple of media effects studies (e.g., Chaffee & Schleuder, 1986), respondents' attention to news stories about both the lake and risks specific to each topic across separate media (newspaper, TV, radio, and interpersonal), was assessed using 11-point scales (where 0 = *no attention* and 10 = *a lot*). Factor analysis revealed two factors that cluster by medium. The first, called *General Attention*, consisted of attention to stories about the lake and topic-specific risk for newspapers, television, and interpersonal discussion, omega = .91. The second factor, labeled *Radio Attention*, was made up of measures of radio attention, omega = .99 (see Appendix).

Dependent Variable: Number of Strongly Held Beliefs

As part of the interview, respondents were asked an entire set of questions that operationalized relevant concepts from TPB. Depending on the respondent's assigned risk, target behaviors included avoiding consumption of fish from the local Great Lake, drinking bottled water instead of tap water drawn from the lake, and taking used or leftover oil and chemicals to a disposal center instead of tossing them into the trash or pouring them down the drain. Respondents questioned about the health of the lake ecosystem were told that the phrase *oil and chemicals* referred to used motor oils and other petroleum products and chemicals such as old insect or weed killers, paint thinners, solvents, chemical fertilizers, and similar substances people sometimes have around their homes.

All respondents were presented with a set of items, derived primarily from presurvey focus groups, designed to measure their pertinent behavioral beliefs (i.e., beliefs about outcomes and other attributes that they might associate with their performing the target behavior and that they might consider in deciding how to behave) and outcome evaluations (i.e., the positive or negative value they put on each outcome or attribute associated with the behavior).

To report relevant behavioral beliefs (see Appendix), individuals asked about Great Lakes fish consumption indicated the extent to which they take into account (a) risk from PCBs, (b) convenience, (c) nutrition, (d) taste, (e) meal variety, (f) expense, and (g) preparation time in deciding whether to eat fish from the local Great Lake. Individuals asked about possible water

hazards indicated whether they consider (a) risk from a waterborne parasite, (b) risk from chemicals in the water, (c) convenience, (d) taste, (e) expense, (f) refreshment, and (g) which takes more time to do when they decide whether to drink bottled water instead of the lake-drawn tap water. Those questioned about the lake ecosystem indicated if they consider, when deciding whether to take oil and chemicals to a disposal center, (a) whether it might affect the health of the local Great Lake, (b) convenience, (c) expense, (d) effort, (e) time, (f) whether they would feel like they are doing something for the environment, and (g) whether they would feel like they are a part of the community. Individuals provided responses by using a 5-point, Likert-type scale that ranged from 1 (*strong disagreement*) to 5 (*strong agreement*) that they take into account each factor when deciding whether to perform the target behavior.

The number of strongly held beliefs by each respondent was calculated by counting the number of outcome-related beliefs he or she endorsed (by "strongly" agreeing) as being important factors to consider when the respondent contemplates performing a specific behavior. Including those statements endorsed as "strongly agree" by respondents was expected to minimize the effects of social desirability biases and respondent agreeability in the interview situation. To minimize problems of skewness and kurtosis in the resulting measure, the final score for each individual in each topic area was derived by adding 1 to the obtained score and deriving the base-10 log of the resulting sum (M = .17, SD = .24).

Dependent Variable:
Belief Evaluation Strength

Respondents also provided evaluations of the beliefs associated with each hazard outlined earlier on 5-point Likert scales assessing the degree to which they agreed or disagreed with each evaluation statement; for example, "Anything that lowers my risk of becoming ill from PCBs is good" and "Anything that takes a lot of time is bad." Operationalizing the theory of planned behavior measures in a telephone survey context rather than using a paper-and-pencil or mailed questionnaire format required changes in the usual scaling techniques used for TPB studies. TPB measures are usually operationalized on 7-point, bipolar scales (e.g., "good-bad" for an evaluation measure, "likely-unlikely" for a behavioral belief measure, etc.) that subjects or respondents can see before them as they mark a response. Pilot testing found that respondents attempting to use 7-point bipolar scales of this or a similar type in a telephone interview experienced difficulty answering questions, and interviewers found the process clumsy at best. To avoid unnecessary

measurement error, the questions were reworked so that respondents could use a 5-point Likert scale that included responses of *strongly agree, agree, feel neutral, disagree*, and *strongly disagree*.

Because our research hypotheses focus on relationship strength, not direction, a scale reflecting evaluation strength was created by recoding responses so that extreme agreement or disagreement was coded as high, (dis)agreement coded as medium, and neutral as a low scale value. The separate items were then summed to obtain a measure reflecting evaluation strength (M = 7.11, SD = 1.88, alpha = .70).

Dependent Variable: Strength of Cognitive Structure

As noted earlier, the strength of cognitive structure (i.e., strength of indirect attitude), not direction, is of primary concern when examining processing depth. Strength of cognitive structure—a belief-based indirect measure of attitude (Ajzen, 1991; Ajzen & Driver, 1992) sometimes referred to as *indirect attitude*—was constructed by multiplying (Belief × Evaluation) each belief by its corresponding measure of evaluation. Each product compound (e.g., B × E), which could take on positive or negative values, then was folded over to reflect strength regardless of attitudinal direction, and then all seven folded variables were added to reflect an indirect measure of attitude strength (M = 24.34, SD = 8.47, alpha = .70). Although reliabilities for evaluation and attitude strength are somewhat low, it is important to note that the belief-based measures used were furnished by respondents in a pilot study designed to elicit a wide range of salient beliefs germane to the topic and thus were not selected, unlike items on standard attitude scales, according to criteria that guarantee high internal consistency.

Results

The analyses performed concentrated on the relationships the two information-processing variables had with the three measures of processing depth. Analyses proceeded by examining these relationships in the overall sample and then by examining replications of results within community and topic subsamples. In particular, we expected to find a positive relationship between systematic (Hypotheses 1a through 1c) processing and the number of strongly held beliefs and evaluation and attitude strength. And we also anticipated finding a negative relationship between heuristic processing (Hypotheses 2a through 2c) and these three indicators of processing depth.

Table 2
Relationship of Risk Information Processing to Number of Behavioral Beliefs Considered and Evaluation Strength by Community and Risk

	Correlation With					
	Number of Strongly Held Beliefs		Evaluation Strength		Cognitive Structure Strength	
Sample/Subsample	Systematic Processing	Heuristic Processing	Systematic Processing	Heuristic Processing	Systematic Processing	Heuristic Processing
Overall (n = 887)	.23***	–.19***	.25***	–.21***	.28***	–.17***
Milwaukee (n = 441)	.30***	–.19***	.31***	–.21***	.33***	–.13**
Cleveland (n = 446)	.16***	–.18***	.21***	–.21***	.23***	–.21***
Fish hazard (n = 528)	.21***	–.14***	.23***	–.18***	.24***	–.12**
Tap water hazard (n = 204)	.23***	–.22***	.20**	–.20*	.29***	–.22**
Lake ecological risk (n = 155)	.23**	–.23***	.33***	–.18*	.29***	–.13†

Note. Table entries are partial correlation coefficients controlling for education, income, age, gender, and minority status.
*p < .05. **p < .01. ***p < .001, two-tailed. †p < .05, one-tailed.

In the entire sample, the number of strongly held behavioral beliefs individuals consider when pondering a risk-related behavior is positively related to systematic processing of risk information, $r = .23, p < .001$, and negatively correlated with heuristic processing, $r = -.19, p < .001$, as shown in Table 2. In addition, evaluation strength is positively associated, $r = .25, p < .001$, with systematic processing and negatively related, $r = -.21, p < .001$, to heuristic processing. In addition, this pattern is repeated when considering cognitive structure strength for both systematic processing, $r = .28, p < .001$, and heuristic processing, $r = -.17, p < .001$. Moreover, this general relationship is consistent within each community and in regard to each risk-related behavior (i.e., topic). Controlling for basic demographic variables, Hypotheses 1a through 1c and Hypotheses 2a through 2c received empirical support.

Prior to the use of regression, correlational analysis (data not shown) revealed an unexpected negative relationship between PIGC and all three dependent variables. Further analysis revealed that the relationship between PIGC and the dependent variables was nonlinear and followed a U-shaped curve. A squared term was created to model this nonlinearity (Aiken & West, 1991), and the term's statistical significance was confirmed using hierarchical regression, with the interaction term entered last, after first entering controls for demographic variables and the main effect term for PIGC. Based on this preliminary analysis, the PIGC-squared term was included in the final regression models.

Multiple regression (Table 3) was used to assess the robustness of heuristic and systematic processing variables, with simultaneous controls for standard demographic factors such as gender, age, education, income, location of the study, panel sensitization, and type of hazard. Additional controls derived from the RISP model include measures of information sufficiency, media beliefs, perceived information gathering capacity, and attention to the topic. The model for total number of beliefs in its original metric as count data was estimated using poisson regression (Greene, 1995). The models for evaluation and cognitive structure strength utilized standard ordinary least squares regression. For a sample size of 887, the regression model (with power = .80, alpha = .05) can detect an effect size of approximately .008 (Hintze, 1996).

The results indicate that demographic factors have direct relationships with all three dependent variables. However, they demonstrate no empirical overlap. Women, minority members, residents of Milwaukee, and new respondents were more likely to consider a wider range of strongly held beliefs when contemplating any of the three hazards studied. Older respondents were more extreme in their evaluations of the beliefs under consideration. In addition, the strength of evaluations varied by hazard type on a comparative basis. Respondents asked about fish in contrast to respondents who

Table 3
Predictors of Number of Behavioral Beliefs Considered, Evaluation Strength, and Attitude Strength

Predictors	Number of Beliefs[a]	Evaluation Strength[b]	Strength of Cognitive Structure[b]
Intercept	0.662	9.183*	30.704
Gender[c]	0.260*	–0.010	0.061
Age	–0.005	0.008*	0.007
Education	–0.022	–0.024	–0.130
Income	–0.002	–0.002	–0.017*
Race[d]	0.349*	0.087	1.024
City[e]	–0.259*	–0.038	–0.802
Panel sensitization[f]	–0.226*	0.067	–0.552
Fish hazard[g]	0.046	0.222	1.126
Water hazard[g]	–0.006	–0.487*	–1.616
Perceived information gathering capacity (PIGC)	–0.358*	–0.823*	–2.128
PIGC-squared	0.026*	0.069*	0.175
Perceived current knowledge	0.005*	–0.003	0.004
Knowledge sufficiency threshold	0.003	0.003	0.020
Channel beliefs: media distort	0.071*	0.124*	0.708*
Channel beliefs: validity cues	0.227*	0.241*	1.323*
General attention	0.010	0.129	0.154
Radio attention	0.033 (.11*)	–0.055 (.11*)	0.164 (.12*)
Systematic processing	0.461*	0.491*	2.949*
Heuristic processing	0.036 (.03*)	–0.076 (.03*)	0.670 (.04*)
Total *R*-squared	0.14*	0.14*	0.16*

Note. n = 887. Parenthetical entries are *R*-squared change for block.
a. Coefficients are maximum likelihood estimates.
b. Coefficients are ordinary least squares estimates.
c. Coding: females high, males low.
d. Coding: minority high, nonminority low.
e. Coding: Cleveland high, Milwaukee low.
f. Coding: new respondent low, panel member high.
g. Lake ecological hazard is comparison group.
*$p < .05$.

gave their views about environmental risk to the lake were more extreme in their evaluations. Respondents questioned about drinking water were less polarized in their judgments than were respondents asked about the lake. And respondents with lower household income demonstrated stronger cognitive structures with regard to the risks under discussion.

The findings also indicate that one set of control variables derived from the RISP model—channel beliefs—appears to be consistently related to beliefs, evaluations, and cognitive structure. Perceived information gathering capacity (PIGC and PIGC-squared) is significantly related to the number

of strongly held beliefs and evaluation strength, whereas perceived current knowledge is positively associated to the total number of beliefs. Neither attention scale demonstrated significant results.

Most pivotally, however, for the purposes of this study is the finding that systematic processing demonstrates a positive relationship with the total number of tightly held beliefs actively considered by respondents, evaluation strength, and cognitive structural (indirect attitude) strength. The lack of significant findings for the heuristic processing scale in the regression models appears to be a function of including the systematic processing scale in the analysis. Models excluding the systematic processing scale show heuristic processing is significantly and negatively related to all three dependent variables (data not shown). Given that systematic and heuristic processing are intercorrelated ($r = -.48$), the results suggest that when predicting depth of processing, systematic processing carries more weight than heuristic processing. With controls, tests of effect size for HSM variables indicate heuristic and systematic processing entered as a final block account for significant increments in variance accounted for, as follows: total beliefs, $R^2 = .03$, $p < .001$; evaluation strength, $R^2 = .03$, $p < .001$; and cognitive structure strength, $R^2 = .04$, $p < .001$.

Discussion and Conclusions

Based on the model of risk information seeking and processing (Griffin et al., 1999), Eagly and Chaiken's (1993) heuristic-systematic model of information processing, and Ajzen's (1988) theory of planned behavior, this study examined the proposition that the mode of processing of risk-related information employed by individuals would be related to cognitive structure and evaluation strength and to the number of strongly held beliefs about the risk utilized when considering possible actions. The analysis had a particular focus on the role of systematic processing, based on Eagly and Chaiken's reasoning that systematic processing leads to the establishment of stable attitudes. And drawing on TPB, greater depth of (systematic) processing of risk-related information is thought to enhance attitude stability because a greater number of relevant behavioral beliefs would be accessed, weighed, and actively considered. In the TPB formulation, behavioral beliefs and evaluations are part of what has been termed *cognitive structure* or *indirect attitude*, a predictor of attitudes, behavioral intention, and ultimately, behavior.

The present analysis found that risk-related beliefs (see Appendix) are among the most commonly accessed cognitions considered by individuals when they contemplate risk-related actions, suggesting that these beliefs have great potential to influence an individual's overall hazard assessment

and behavioral judgments. More important, however, is the finding that individuals who have processed risk information more systematically appear to demonstrate a greater depth of processing, as indexed by greater evaluation and (indirect) attitude strength and through incorporating a greater number of strongly held behavioral beliefs in their thinking about potential remedial actions. Moreover, these findings show great consistency across health and environmental hazards and locations and maintain their consistency despite the application of numerous demographic and RISP model control variables and in spite of measures with moderate reliability. These results take on additional theoretical significance because finding such relationships is a necessary precondition for temporal analysis that examines issues of stability and change through time suggested by the theory of planned behavior.

Given the importance of heuristic and systematic processing to the RISP model, there is the need for refined measurement, particularly in the case of heuristic processing, which is an entirely new scale. In addition, more recent work (Chaiken, Giner-Sorolla, & Chen, 1996; Chen & Chaiken, 1999) suggests that accuracy, defensive, and impression motivations condition information processing. The present measurement approach, which assumes accuracy as a primary motive, could be expanded to include measures of biased heuristic and systematic processing. Possible applications include voting and time of decision (Chaffee & Choe, 1980), third-person effects (Perloff, 1999), and the spiral of silence (Noelle-Neumann, 1991).

There are several limitations to the study that should be noted in detail, the first focusing on the performance of perceived information gathering capacity. Two explanations might be advanced to account for the measure's low reliability and unexpected nonlinearity. First, the scale was made up of only two items. Given adequate interitem correlations, reliability largely is a function of the number of variables in a scale. When designing questionnaires, researchers must balance a desire for reliable measures with considerations about cost, time, and the breadth of topics covered. Clearly, more items should be added to the scale in future studies. Second, the study found a curvilinear relationship between PIGC and two dependent variables. Although possible to model this U-shaped relationship in the data analysis, the matter of providing an adequate theoretical account remains open. The most likely possibility, in our view, is that a person's perception of information gathering capacity may hinge not only on assessments about the quality and nature of the information environment but also turn on questions of a person's perceived ability to handle such information. Future studies should assess these possibilities.

More generally, we believe that the use of 5-point Likert-type scales used throughout the study likely attenuated reliability. Indeed, this point is

bolstered by the finding that our highest reliabilities were associated with measures using 11-point scales. As noted earlier, the sample size provided ample statistical power to detect even small (R^2 = .008) effects. By conventional standards, the magnitude of effects was small—on the order of 3% to 4% (Cohen & Cohen, 1983), although it is important to note that controlling for 18 variables, the effect sizes reported are conservative; without controls, effect size ranged from 6% to 8%. Nonetheless, the moderate and low reliabilities found in many of the scales likely suppressed the overall effect size and in particular attenuated effect size for the heuristic and systematic variables. In addition, the lower reliabilities may have truncated what would otherwise be significant relationships.

RISP-derived variables, thought to be antecedents of systematic and heuristic processing, functioned in this analysis as statistical controls. Although not central to the research concerns raised in this report, several findings merit particular comment. First, beliefs about mass media content and functioning appear to contribute to greater depth of processing of information about environmental and health hazards. Previous research had established the importance of media beliefs in the realm of politics and public opinion, and these results would appear to extend the scope of this phenomenon to the area of environment and health. Second, estimates of current knowledge rather than knowledge needed for sufficiency emerged as a significant predictor of total number of beliefs. This finding appears to be most consistent with an interpretation that respondents were reflecting their current situation. One would expect, for example, that knowledge sufficiency threshold would be most predictive of information seeking and processing in the future, and panel analysis could profitably address this question. Third, media attention did not emerge ultimately as a significant predictor. This finding suggests that although attention and information processing variables overlap as constructs, (a) attention is best seen as necessary precondition for subsequent processing, and (b) attention is not a mere surrogate for processing. These points are further supported when examining the performance of the attention scales in a hierarchical regression model (data not shown), with heuristic and systematic processing entered as a final block. Prior to the entry of the final block, attention was a significant predictor. However, given the cross-sectional data used, it is possible that the implied causal order is reversed. Were this to be the case, the findings would imply that heuristic and systematic processing variables are more trait-like in nature, whereas attention has a more state-like or transitory quality. This would also imply that

heuristic and systematic information processing would influence evaluation strength and number of beliefs directly and indirectly through attention processes.

The purpose for including commonly used demographic variables was to control for a variety of social and psychological forces that represent potential alternative explanations for the results but for which we did not have the resources to measure directly in the questionnaire. Some results are consistent with earlier research. For example, the findings that gender and race are associated with a greater number of strongly held beliefs is consistent with previous research suggesting that minority group members generally perceive more risk. The ultimate meaning of other results requires a more speculative approach. For example, the analysis shows that age is positively related to evaluation strength. Age, of course, can represent maturation or reflect cohort effects. We cannot tell here. One possibility, grist for future research, is that with age comes stronger evaluation of what is a good or bad outcome (a maturation effect) based on the experience that comes with age. Similarly, Milwaukeeans seem to take more beliefs into account than people from Cleveland. Whether that is a by-product of Milwaukee's experience with cryptosporidiosis, with the role of the lake in local culture, or something else would have to be explained by studies that specifically examine such third variables. Why folks with lower income have a slightly stronger strength of indirect attitude (cognitive structure) similarly requires an examination of explanatory variables not in the study. Future research can and should examine these factors and associated mechanisms more fully.

Finally, the results have methodological importance because the study (a) demonstrates an application of measuring heuristic-systematic processing in a field setting, (b) demonstrates the operationalization of elements derived from the theory of planned behavior through a telephone survey, and (c) represents the first time that researchers have linked heuristic-systematic processing with elements of the theory of planned behavior in a field setting. Our own future research will examine the relationship of these cognitions to the rest of the elements of TPB as applied to these risks, looking in particular for a relationship of systematic processing of risk information to the temporal stability of risk-reducing behavior. However, perhaps of greater interest and consequence to other researchers is the potential to extend the RISP model and the approach outlined herein beyond the realm of risk and environment to allied areas of communication research that entail information search, processing, and behavior.

Appendix
Descriptive Statistics for Behavioral Belief Items by Topic (1 to 5 Scale, Strongly Disagree to Strongly Agree)

People can really be different from one another when it comes to the things they consider to be important when they make a decision. The following are statements that people have made about what they think is important to take into account when they decide whether to eat fish/drink tap water/take used or leftover oil and chemicals to a disposal center.

	Mean	Standard Deviation	Percentage Strongly Agree
Fish (n = 528)			
In deciding whether or not to eat fish from Lake [Michigan] [Erie], I take into account			
The taste of fish.	3.86	0.91	19.7
Whether I might be at risk from PCBs.	3.70	1.03	21.4
The variety of my meals.	3.70	0.87	10.6
The nutrition that fish provide.	3.60	0.98	11.0
Which is more convenient to do.	3.11	1.09	6.6
Which is more expensive to do.	3.02	1.05	6.3
In deciding whether to eat fish from Lake [Michigan] [Erie], or to eat something else instead, I take into account which takes more time to do.	2.92	1.06	4.7
Tap water (n = 204)			
In deciding whether to drink bottled water instead of tap water drawn from Lake [Michigan] [Erie], I take into account			
The taste of the water.	3.71	0.90	14.2
Whether I might be at risk from a parasite in the water.	3.47	1.07	14.2
Whether I might be at risk from chemicals in the water.	3.45	1.00	10.3
Which one is more expensive to do.	3.43	1.09	13.2
Which water is more refreshing.	3.29	0.94	4.9
Which one is more convenient to do.	3.27	1.02	4.9
Which one takes more time to do.	2.92	1.04	5.4
Lake ecology (n = 155)			
In deciding whether to take used or leftover oil and chemicals to a disposal center, I take into account			
Whether I would feel like I am doing something for the environment.	4.14	0.60	23.2
Whether it might affect the health of Lake [Michigan] [Erie].	3.97	0.80	20.6
Whether I would feel like I am a part of the community.	3.72	0.90	11.6
Whether it is convenient to do.	2.88	1.08	3.9
Whether it takes a lot of time to do.	2.88	1.05	2.6
Whether it would require a lot of effort to do.	2.86	1.02	1.9
Whether it is expensive to do.	2.84	1.03	1.9

Risk Information Seeking and Processing Model Scale Items

MEDIA BELIEFS

The following are statements that people have made about information from the mass media and other sources. For each statement, please tell me whether you strongly agree, agree, feel neutral, disagree, or strongly disagree.

Media Distort
- The media often exaggerate and sensationalize the news.
- News media often represent their own bias and interests.
- News stories are just a series of unconnected events that don't add up to much.

Validity Cues
- When the same information appears in many places, I'm more likely to believe it.
- Stories with statistics are more believable than those without.
- Individual news items may seem like bits and pieces, but in the long run they form a meaningful pattern.

INFORMATION SUFFICIENCY

Current Knowledge
- Now we would like you to rate your knowledge about [topic]. Please use a scale of zero to 100, where zero means knowing nothing and 100 means knowing everything you could possibly know about this topic. We would like you to estimate how much knowledge you would need to deal adequately with risk of eating fish/drinking water/achieve an understanding of threats to the health to the lake.

Sufficiency Threshold
- Of course, you might feel you need the same, more, or possibly less information about this topic. Using a scale of zero to 100, how much information would be sufficient for you, that is, good enough for your purposes.

PERCEIVED INFORMATION GATHERING CAPACITY

The following are statements that people have made about information from the mass media and other sources. For each statement, please tell me whether you strongly agree, agree, feel neutral, disagree, or strongly disagree.
- It's hard for me to get useful information about this topic (reversed).
- If I wanted to, I could easily get all the information I need about this topic.

GENERAL MEDIA ATTENTION

On a scale of 0 to 10, where 0 is none and 10 is a lot, how much attention do you pay
- To TV news about Lake [Michigan] [Erie]?
- To TV news stories about risks from eating/drinking Lake [Michigan] [Erie] fish/water?
- To newspaper stories about Lake [Michigan] [Erie]?
- To newspaper stories about risks from eating/drinking Lake [Michigan] [Erie] fish/water?
- When discussions among friends, coworkers, or family turn to Lake [Michigan] [Erie]?
- When discussions among friends, coworkers, or family turn to risks from eating/drinking Lake [Michigan] [Erie] fish/water?

(continued)

Appendix (continued)

RADIO ATTENTION
To information on the radio about Lake [Michigan] [Erie]?
To information on the radio about risks from eating/drinking Lake [Michigan] [Erie] fish/water?

DEMOGRAPHICS
Education
What is the highest grade or year of school that you have completed?
Coding: (1) eighth grade or less, (2) some high school, (3) high school graduate or GED certificate, (4) some technical school or vocational training, (5) technical school graduate, (6) some college or associate degree, (7) college graduate, (8) postgraduate or professional.
Income
And, just roughly, what was your total household income last year from all sources?
Coded in thousands.

Notes

1. This article is based on work supported in whole or in part by the federal Agency for Toxic Substances and Disease Registry.

2. A third wave (n = 460) of respondents was interviewed between October 1998 and March 1999.

3. Alpha is a lower bound estimate of reliability when interitem variances are not equal and thus represents a conservative estimate (Lord & Novick, 1968), whereas omega provides a more accurate estimate of reliability (Carmines & Zeller, 1979). The reliability coefficients reported herein are lower than desired and sometimes fall below the conventional standard of .80 prevalent in fields such as psychology. However, Robinson, Shaver, and Wrightsman (1991) advocated the following standard: Reliability coefficients .80 and above are "exemplary," coefficients in the .70 to .79 range are "extensive," .60 to .69 "moderate," and below .60 "minimal."

Adopting this standard, reliabilities are exemplary for media attention; extensive for evaluation strength, attitude strength, and media distort; moderate for validity cues and systematic and heuristic processing; and minimal for perceived information gathering capacity.

4. This approach to the factor analysis was driven by the design of the overall study, specifically, a three-wave, panel design, sample survey with new respondents added in the second and third waves as controls for sensitization in the panel. Although less of a concern at a single time point, this approach is designed to produce comparable factor scores across all respondents and all waves of the study by using the same factor score weight coefficient for a given item across all waves. Scales based on weights from the overall sample reported herein and wave-specific factor scales demonstrate a high degree of consistency, with correlations as follows: systematic processing, r = .96; heuristic processing, r = .93; media distort, r = .98; and validity cues, r = .97. The factor-analytic model used throughout this report has as its focus explaining common or variance shared by the indicators. This analytical approach is in contrast to principal components analysis, which has as its goal the extraction of maximum variance from a set of items (Pedhazur & Schmelkin, 1991).

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