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Testing Links Among Uncertainty, Affect, and Attitude Toward a Health Behavior

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# Abstract

This study examines the conceptual linkages between individuals’ uncertainty judgments and affective reactions (worry and anger) within the context of an environmental health risk. It uses data from a longitudinal study of people’s reactions to the risks of eating contaminated fish from the Great Lakes that employed the risk information seeking and processing model and incorporates a set of variables from the full model, which includes preventive behavior. Findings support the model and indicate that worry and anger strongly influenced uncertainty judgments but worry and anger influenced attitudes toward fish avoidance and information insufficiency differently.

# Introduction

Individuals’ senses of uncertainty about a risk and their affective reactions to that risk often figure prominently in subsequent behavioral decisions (Slovic, Peters, Finucane, & MacGregor, 2005). How those factors interact with each other, as well as with other aspects of individuals’ responses to a risk, remains less well understood. It is important to study these relationships because they may help explain how negative affect may influence one’s perception of uncertainty about a health risk. This study will utilize the risk information seeking and processing (RISP) model, which includes measures of both uncertainty and affective perceptions as part of a larger array of predictors (Griffin, Dunwoody, & Neuwirth, 1999). Despite the presence of uncertainty in the model, few RISP studies have employed it. Although most of those studies have used information seeking as a dependent variable, this study will take advantage of the original, fuller model, which also sought to explain behavioral intentions by incorporating components of the theory of planned behavior (TPB; Ajzen, 1991).

To analyze the relationships that affective responses and uncertainty judgment have with risk information-seeking and risk-preventive behaviors, we use panel data from a survey of perceptions of the risk of eating contaminated Great Lakes fish conducted by Griffin et al. (1999). This RISP data set is rare in that it includes a 1-year lag between behavioral intention measures and self-reported behaviors.

Using the risk of eating contaminated Great Lakes fish as an issue, this current study seeks to advance the RISP model by investigating conceptual links among affective responses toward a health risk, uncertainty judgments about the risk, and behaviors that would address the risk. More specifically, we propose a theory-building effort to enhance the RISP model by formally evaluating uncertainty’s role vis-à-vis other variables in the model. Illuminating uncertainty’s role not only is of interest to risk communication researchers but also may help risk managers better understand how people’s information-seeking and risk-preventive behaviors are shaped.

# The Study Context: The Risk of Eating Great Lakes Fish

Fishing in North America (American Sportfishing Association, 2013), particularly in the Great Lakes region (Imm, Knobeloch, Anderson, & the Great Lakes Sport Fish Consortium, 2005), is a popular source of food, recreation, and social interaction among local residents and anglers. Authorities in states bordering the Great Lakes regularly disseminate health advisories that explain how to minimize exposure to chemicals that may contaminate these fish. Such cautionary messages have not diminished the popularity of eating Great Lakes fish (Imm et al., 2005), and commercial- and sport-caught fish from the lakes are readily accessible to area residents at local restaurants and fish markets (Turyk et al., 2012). Minimizing the risks from eating contaminated fish by encouraging the public to seek information and to act accordingly is important.

Although fish offer substantial health benefits (Turyk et al., 2012), those that are contaminated by polychlorinated biphenyls or by mercury—both found in the Great Lakes—pose risks of cancer and fetal developmental problems (Weisskopf et al., 2005). Therefore, depending on the frequency and amount of fish eaten and contaminant levels in those fish, consuming Great Lakes fish can be harmful (Anderson et al., 1998; Turyk et al., 2012). The mixture of benefits and potential harms can lead to uncertainty about the role of fish in a healthy diet (Castro-González & Médez-Armenta, 2008), making an effort to understand the factors that influence people to adopt behaviors consistent with these risks a priority. Those behaviors include avoiding or limiting consumption of the fish; avoiding eating large fish, which are more likely to have accumulated toxins; and cleaning and preparing fish in ways that minimize exposure to toxins.

# Risk Information Seeking and Processing Model

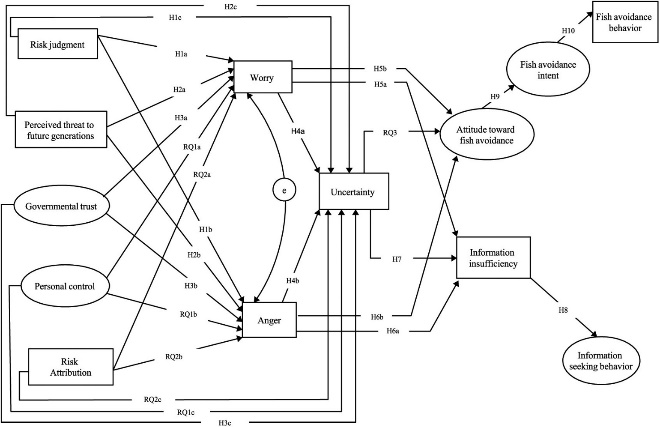
The RISP model seeks to explicate the underlying processes that lead individuals to invest in information seeking and subsequent preventive behaviors (Griffin et al., 1999). Important to the RISP model is the concept of information insufficiency. It is built on the sufficiency principle articulated by the heuristic-systematic model (Eagly & Chaiken, 1993), which asserts that people seek a “sufficient” degree of confidence in order to make judgments and will exercise whatever effort is required to attain that level of judgmental confidence. Information insufficiency is defined as the perceived amount of information an individual would need to deal confidently with a risk (Griffin, Neuwirth, Dunwoody, & Giese, 2004). Operationally, information insufficiency is the self-reported gap between the information an individual already possesses (current knowledge) and the information she or he believes is needed to cope with a risky situation (sufficiency threshold). The larger the gap, the model posits, the more motivated an individual will be to seek information about the risk and to process that information more effortfully. The RISP model predicts that factors such as people’s affective response to the risk (e.g., worry, anger) and their perceptions of the risk’s hazard characteristics should influence information insufficiency, which, in turn, will affect information-seeking and -processing behaviors.

To extend the explanatory reach of the RISP model from information seeking and processing to health behavior, as articulated in the original model, Griffin and his colleagues drew on the TPB (Ajzen, 1991). Specifically, the model postulates that individuals’ perceptions of preventive behaviors and hazard characteristics should ultimately influence their attitude toward those behaviors and, in turn, influence their intention to engage in them.

Studies of a variety of health and environmental risks have provided evidence for the usefulness of the RISP model (Yang, Aloe, & Feeley, 2014). However, most studies applying the model to date have attended to the segment of the model focused on information seeking and processing outcomes; only a few studies have engaged the TPB aspect of behavior in the model (e.g., Griffin, Neuwirth, Giese, & Dunwoody, 2002). The current study seeks to grapple with the second stage of the original model by investigating the role of uncertainty and the influence of affective responses on fish consumption behaviors.

Communication scholars have developed a number of theoretical frameworks to explore uncertainty (see Bradac, 2001, for a review); here, we employ Brashers’s (2001) definition: A person’s judgment of the level of uncertainty inherent in a risk represents the degree to which he or she perceives that risk as being ambiguous, complex, or unpredictable. The more uncertainty felt about a risk, the less control people believe they have.

Individuals’ evaluations of the uncertainty of a health risk can influence their perceptions and attitudes (e.g., Johnson & Slovic, 1998; Visschers, 2017). However, studies using the RISP model have yet to explore the role of uncertainty judgment and its relationships with affective responses and information insufficiency. Our study attempts to fill this gap. We argue that uncertainty judgment may serve as a link between affective reactions to a health risk and information insufficiency in the RISP model (see Figure 1). Specifically, affective reactions arise from people’s appraisal of hazard characteristics and may serve as informational input to individuals’ judgments about the uncertainty of that hazard. The greater this sense of subjective uncertainty about the complexity and unpredictability of the hazard and its outcomes, then, the greater the perceived information gap, as the sense of uncertainty provides an internal cue that an individual’s current level of information about the hazard is insufficient to adequately cope with the hazard. That sense of insufficiency, according to the model, prompts individuals to seek information and to process that information more effortfully.



**Figure 1**. Hypothesized model.

Note: H = hypothesis; RQ = research question. *N* = 334. “e” stands for correlation between error terms.

Given that the RISP model employs concepts from the TPB, judgments about behavioral intentions in the model are assumed to stem from conscious and goal-directed processes. However, affect plays an important role in risk decision making and behavior (Slovic et al., 2005). Past studies using the RISP model have paid relatively little attention to how affective responses could influence health behavioral intentions via their impact on attitude. Our study seeks to remedy that.

This study utilizes a subset of variables in the RISP model—essentially the key variables of perceived hazard characteristics and affective, cognitive, and behavioral responses—to examine the roles of uncertainty and affect. A small number of previous studies have used the RISP model to examine the effect of risk information-processing strategies on people’s behavioral beliefs and attitude strength toward health behaviors (Griffin et al., 2002), thus linking risk information processing to behavioral intentions via behavioral beliefs and attitude strength. Here, we focus instead on the influence of negative affect and uncertainty on two behavioral reactions to the risk, as we suspect that information-seeking behavior and fish avoidance behavior are two conceptually distinct behavioral reactions. It is important to note that while this study employs a number of concepts offered by RISP, it is not a test of the RISP model per se, although we will make some recommendations at the discussion stage for its modification.

In the next section, we review the theoretical underpinnings of the relationship between affective reactions and uncertainty judgments, as well as the influence of affective responses on attitudes toward a specific behavior.

## Affective Responses and Uncertainty

Affective responses may function as a source of information for individuals, informing subsequent judgments about the uncertainty of the risk. The feelings-as-information hypothesis offers a theoretical explanation for how people might use affective reactions as information for making judgments. The hypothesis (Schwarz, 2010) argues that people are likely to make use of their affective responses to form an evaluative judgment of an event, especially when the judgmental tasks are complex and demanding. More specifically, people may ask themselves, “How do I feel about the event?” when they form a judgment. The affective reactions triggered by the event, thus, may function as a source of information relevant to the judgmental task. Evaluating the uncertainty of the risks of eating contaminated fish from the Great Lakes is a difficult and demanding task, making individuals’ emotional reactions to the risks potentially relevant to that judgment.

Although uncertainty may be associated with positive emotions such as hope, this study focuses on the relationship between specific negative affective states (anger and worry) because of their relevance to the risks of eating contaminated fish.

## Affective Responses and Behavioral Intent

Although the TPB has received substantial support over the years in explaining an individual’s health-related behaviors, one major critique is the theory’s insufficient attention to emotional influences on behavior (Conner & Armitage, 1998). Recent research on the psychology of risk has shown that affect plays a vital role in risk judgment and behavior (Slovic et al., 2005).

Within the TPB framework, affect may shape one’s intention to engage in risk-preventive behaviors through its influence on attitude toward those behaviors, in part because both affect and attitude are evaluative reactions to a specific behavior (Clore & Schnall, 2005). That is, affective response is a form of evaluation; as such, the evaluations manifested in affect toward the behavior may map onto the evaluative orientation of attitude toward the behavior. Taking the consumption of fish from the Great Lakes as an example, the evaluations embodied in emotional reactions to the risks of eating fish may be conceptually similar to the evaluative attitudes about related behavioral intentions (e.g., avoidance).

Given that different types of affect are associated with different appraisals of an event (C. A. Smith & Ellsworth, 1985), they are likely to influence attitude differently. Thus, different affective responses toward eating Great Lakes fish—in this case worry and anger—may have differential impacts on attitude toward avoiding the consumption of those fish.

## Hypotheses and Research Questions

### Perceived Hazard Characteristics, Affective Responses, and Uncertainty

The RISP model proposes that people’s reactions to a hazard are influenced by individuals’ perceptions of the characteristics of that hazard. When considering the risk of eating contaminated fish from the Great Lakes, five variables in the RISP model that are linked to perceived hazard characteristics are relevant to this study: risk judgment, perceived threat to future generations, trust in government, personal control, and risk attribution (Griffin et al., 1999; Griffin et al., 2008). Below, we briefly explain these five factors and their potential influences.

A *risk judgment* is one’s subjective appraisal of both the likelihood that a risk may affect one and the severity of that impact, should it occur. A *perceived threat to future generations* denotes the individual’s assessment of how likely it is that the health risk would pose harm to future generations. Although these two constructs tap into a person’s risk perceptions, they are conceptually distinct. Risk judgment is an individual-level risk assessment while perceived threat to future generations is societal level in nature. Evidence has shown that people who perceived greater risk to themselves or to future generations expressed greater uncertainty (Powell, Dunwoody, Griffin, & Neuwirth, 2007) and experienced higher levels of worry or anger (Griffin et al., 2008; Yang & Kahlor, 2013).

*Trust in government*, which refers to the extent to which individuals depend on the government or its authorized agencies to protect them from health threats, plays a key role when dealing with a potential threat to the public because most people do not have the expertise to assess the risk themselves (Cvetkovich, Siegrist, Murray, & Tragesser, 2002). Evidence suggests that people with less trust in the government are more likely to perceive greater uncertainty (Powell et al., 2007) and to experience negative emotions such as worry and anger (Griffin et al., 2004; Griffin et al., 2008).

Based on the RISP model and previous studies, we propose the following hypotheses (H) regarding these three concepts:

**Hypothesis 1:** Risk judgment will be positively associated with (a) worry, (b) anger, and (c) uncertainty.

**Hypothesis 2:** Perceived threat to future generations will be positively associated with (a) worry, (b) anger, and (c) uncertainty.

**Hypothesis 3:** Governmental trust will be negatively associated with (a) worry, (b) anger, and (c) uncertainty.

*Personal control*, which reflects individuals’ perceptions of their ability to influence the level of harm posed by a threat, has been positively associated with anger toward regulatory agencies (Griffin et al., 2008). However, the finding of another study using the RISP model indicated no significant relationship between personal control and worry (Griffin et al., 2004). Given those mixed results, we pose the following research question (RQ):

**Research Question 1:** Does personal control relate to (a) worry, (b) anger, and (c) uncertainty?

*Risk attribution* is a component of perceived hazard characteristics in the RISP model because people’s causal attributions for a hazardous outcome could influence how they react emotionally and behaviorally (Griffin et al., 2008). For example, people who ascribed flood damage to poor government management strategies were likely to be angrier; as a result, in one study, they tended to express a greater need for information and indicate an intention to engage in more active information seeking, presumably to reassert their own control over the risky situation (Griffin et al., 2008).

Causal attribution may also have an impact on worry. An attribution research study in psychology examined how people perceived their financial position in life and their attributions to causal agents (E. R. Smith & Kluegel, 1982). The findings indicated that people who perceived themselves as poor felt more worry when they attributed the causes of their financial situation to their social contexts.

For the purpose of this study, we conceptualize *risk attribution* as the degree to which individuals believe that eating the contaminated fish could make them sick. This conceptualization describes the individual’s recognition that an action could influence the probability of an undesirable outcome and, thus, is similar to the TPB concept of a behavioral belief (Ajzen, 1991). Risk attribution could be internal (e.g., my behavior could cause a risk to my health), external (e.g., I incur a risk because of the behaviors of others, including organizations and agencies), or a combination. In our study, we examined the degree to which people consider their own behavior of eating the contaminated fish as a potential cause of illness.

Both worry and anger about potentially becoming ill could be associated with risk attribution (one might expect anger to be more likely if an external agent is perceived as the culprit). Risk attribution might affect uncertainty as well. If individuals realize that their behavior might have negative consequences, that might increase their uncertainty about performing an action that had heretofore seemed risk-free. In addition, people suffering from illnesses face innumerable uncertainties, such as whether health professionals can accurately diagnose the problem, how much those professionals understand the course of disease and prognosis, and whether recommended treatments are likely to be effective. These sources of uncertainty in illness (Mishel, 1997) might also arise in the minds of people wondering whether their behaviors (e.g., eating contaminated fish) might have negative health consequences.

These matters require much more exploration. Thus, we pose the RQ:

**Research Question 2:** Does risk attribution relate to (a) worry, (b) anger, and (c) uncertainty?

### Affective Responses and Uncertainty

Anger and worry are two relevant affective reactions in the context of health risks. Appraisal theory suggests that anger is associated with assessments of one’s own goal obstacles and level of control (Kuppens, Van Mechelen, Smits, & De Boeck, 2003). In the context of health hazards, a feeling of anger is particularly likely to develop when individuals feel they have lost control over a situation (Griffin et al., 2008). Worry in the RISP model is defined as a feeling that reflects the anxiety caused by a future hazard (Griffin et al., 1999). According to the feelings-as-information hypothesis (Schwarz, 2010), affective responses to a health hazard may influence individuals’ judgment. Research on an environmental health risk (Powell et al., 2007) and cancer risk (Han, Moser, & Klein, 2006) has shown positive associations between negative emotions (worry and anger) and uncertainty. Guided by this evidence, we posit the following:

**Hypothesis 4:** Greater levels of (a) worry about and (b) anger toward the risk of eating contaminated fish from the Great Lakes will be positively associated with uncertainty judgments.

### Affective Responses, Information Insufficiency, and Attitude Toward Fish Avoidance

Affective reactions may promote behavioral change through their influence on attitudes toward the behavior (Clore & Schnall, 2005). Anger can lead to efforts to protect one’s health. For example, angry residents in flood-prone areas in one study were motivated to gather more information about the flood risk (Griffin et al., 2008), suggesting that anger increased the need for information (i.e., greater information insufficiency). Because anger is associated with the desire to defend oneself and correct perceived wrongs, angry people with high levels of self-efficacy are more likely to adopt an advocated behavior to “fix” the situation after reading anger-promoting health messages (Turner, 2007).

Similarly, worry prompts individuals to engage in problem-solving processes and threat prevention behavior. For example, worry is an important determinant of personal and government action in service to risk reduction (Baron, Hershey, & Kunreuther, 2000; McCaul, Mullens, Romanek, Erickson, & Gatheridge, 2007).

Thus, we pose the following hypotheses:

**Hypothesis 5:** Worry will be positively associated with (a) information insufficiency and (b) attitude toward fish avoidance.

**Hypothesis 6:** Anger will be positively associated with (a) information insufficiency and (b) attitude toward fish avoidance.

### Uncertainty Judgment, Information Insufficiency, and Attitude Toward Fish Avoidance

Uncertainty about a health risk in this study involves one’s subjective judgment about the ambiguity, complexity, and unpredictability of the consequence of the risk. Griffin et al. (1999) argued that one’s degree of uncertainty about a risk reflects aspects of judgmental confidence regarding that risk. In addition, people are uncertain when they decide that their level of knowledge is not sufficient to permit them to decide what to do (Weary & Edwards, 1996). As a result, uncertainty appraisal in a risk context could heighten the need for more information. We pose the following hypothesis:

**Hypothesis 7:** Greater levels of uncertainty will be positively associated with information insufficiency.

Uncertainty signals a perceived loss of control over one’s environment. As a result, uncertainty is regarded as an aversive mental state that people attempt to reduce (Weary & Edwards, 1996). In this sense, uncertainty can be a behavioral motivator (Hogg, 2000). In the case of this study, avoiding fish from the Great Lakes is one way to reduce the uncertainty of adverse effects. Therefore, people who are uncertain may be motivated to have more positive attitudes toward fish avoidance. However, the relationship between uncertainty and attitude toward a healthy behavior has not yet been examined in the context of risk. Therefore, we pose the following RQ:

**Research Question 3:** Do uncertainty judgments relate to attitudes toward fish avoidance?

### Attitude Toward Fish Avoidance, Information Insufficiency, and Behaviors

Consistent with RISP predictions, much evidence supports the relationship between information insufficiency and information-seeking behavior (Hwang & Jeong, 2016; Yang et al., 2014). A meta-analysis also provides support for the relationship between attitude toward a behavior and an individual’s intention to perform that behavior (McEachan, Conner, Taylor, & Lawton, 2011). Following the same logic of the TPB, behavioral intention is hypothesized as the proximal antecedent to action, and meta-analyses show that behavioral intention is a good predictor of an actual behavior (Conner & Sparks, 2005). Thus, we posit the following hypotheses:

**Hypothesis 8:** Information insufficiency will be positively associated with information-seeking behavior.

**Hypothesis 9:** Attitude toward fish avoidance will be positively associated with intention to avoid fish.

**Hypothesis 10:** Fish avoidance intention will be positively associated with subsequent fish avoidance behavior.

Figure 1 shows a graphical representation of the hypotheses of this study, overlain on the RISP model.

# Method

## Data

This study is a secondary analysis of panel survey data collected by Griffin et al. (1999) from two large Midwestern cities between 1996 and 1999. The current analysis of a subset of 334 respondents was part of this 3-year panel study.1 This study afforded the rare opportunity to examine the influences of affective responses and uncertainty judgments on subsequent behaviors at a later time. To achieve this, we utilized variables from panel survey waves 2 and 3. All but one of the variables come from the Wave 2 survey, while reports of fish avoidance behavior were taken from the Wave 3 survey, conducted a year later.2 The introduction of a time lag between behavioral intention (Wave 2) and reported behavior (Wave 3) allows us to strengthen causality arguments. However, information seeking, the second behavioral reaction in this study, was limited to data from Wave 2 because comparable measures of self-reported information-seeking behavior were not gathered in Wave 3.

## Measures

Table 1 presents reliability calculations for aggregate variables and Pearson’s correlations for the variables. Table 2 presents item wording, measurement scales, and descriptive data for all variables and indices.

**Table 1**. Reliabilities and Correlations of the Variables.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **Reliability** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** |
| 1. Risk judgment | — | 1.00 |  |  |  |  |  |  |  |  |  |  |  |  |
| 2. Perceived threat to future generationsa | — | .32\*\*\* | 1.00 |  |  |  |  |  |  |  |  |  |  |  |
| 3. Personal controlb | .84 | −.06 | .02 | 1.00 |  |  |  |  |  |  |  |  |  |  |
| 4. Governmental trustb | .76 | −.19\*\*\* | −.11 | .01 | 1.00 |  |  |  |  |  |  |  |  |  |
| 5. Risk attributiona | — | .33\*\*\* | .41\*\*\* | .10 | −.11\* | 1.00 |  |  |  |  |  |  |  |  |
| 6. Uncertainty judgmenta | — | .29\*\*\* | .35\*\*\* | −.09 | −.25\*\*\* | .33\*\*\* | 1.00 |  |  |  |  |  |  |  |
| 7. Worrya | — | .33\*\*\* | .32\*\*\* | −.02 | −.17\*\* | .38\*\*\* | .73\*\*\* | 1.00 |  |  |  |  |  |  |
| 8. Angera | — | .30\*\*\* | .32\*\*\* | .04 | −.25\*\*\* | .44\*\*\* | .69\*\*\* | .74\*\*\* | 1.00 |  |  |  |  |  |
| 9. Information insufficiency | — | .14\* | .14\* | .01 | −.17\*\* | .16\*\* | .28\*\*\* | .27\*\*\* | .26\*\*\* | 1.00 |  |  |  |  |
| Current knowledge |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| Sufficiency threshold |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 10. Information-seeking behaviorb | .72 | .15\*\* | .21\*\*\* | .08 | −.07 | .29\*\*\* | .29\*\*\* | .36\*\*\* | .43\*\*\* | .38\*\*\* | 1.00 |  |  |  |
| 11. Attitude toward fish avoidanceb | .75 | .00 | .04 | −.01 | −.04 | .07 | .11 | .10 | .16\*\* | .03 | .08 | 1.00 |  |  |
| 12. Fish avoidance intentb | .94 | .31\*\*\* | .34\*\*\* | .01 | −.23\*\*\* | .47\*\*\* | .36\*\*\* | .37\*\*\* | .42\*\*\* | .06 | .10 | .10 | 1.00 |  |
| 13. Fish avoidance behavior | — | .06 | .13\* | .17\*\* | −.10 | .22\*\*\* | .19\*\*\* | .19\*\* | .21\*\*\* | −.08 | −.01 | −.01 | .44\*\*\* | 1.00 |

aDenotes single item measure. bDenotes Cronbach’s alpha. *N* = 334.

\**p* < .05. \*\**p* < .01. \*\*\**p* < .001.

**Table 2**. Descriptive Data for Key Variables.

|  |  |  |  |
| --- | --- | --- | --- |
| **Concepts** | ***M*** | ***SD*** | **Measures** |
| Risk judgment (risk judgment = perceived susceptibility × perceived severity; 0-100 scale) | 18.99 | 22.43 | (Perceived susceptibility) How likely are *you* to become ill in the future from eating contaminated fish caught in Lake [Michigan] [Erie]? (11-point scale: 0 = *you would have absolutely no chance whatsoever of becoming ill* to 10 = *you are certain to*) |
|  |  |  | (Perceived severity) If you were to become ill from eating contaminated Lake [Michigan] [Erie] fish, how serious do you think this illness would be? (11-point scale: 0 = *not serious at all* to 10 = *it would be as serious as it can possibly be)* |
| Personal control (5-point scale: 1 = *strongly disagree* to 5 = *strongly agree*) | 4.15 | 0.68 | (Item 1) If I want to, I could easily avoid eating fish from the Great Lakes. |
|  |  |  | (Item 2) I have personal control over whether or not I would eat the fish from the Great Lakes. |
|  |  |  | (Item 3) Whether or not I would eat the fish from the Great Lakes is completely up to me. |
| Governmental trust (5-point scale: 1 = *strongly disagree* to 5 = *strongly agree*) | 2.76 | 0.87 | (Item 1) The government is doing a competent job of protecting people’s health from risks related to eating contaminated Great Lakes fish. |
|  |  |  | (Item 2) I trust the government to protect me from risks related to eating contaminated Great Lakes fish. |
|  |  |  | (Item 3) Government officials care about the health and safety of people like me. |
| Perceived threat to future generations (5-point scale: 1 = strongly disagree, 3 = *feeling neutral*, 5 = *strongly agree*) | 3.88 | 1.02 | Contamination of fish in Lake [Michigan] [Erie] threatens the health and safety of future generations. |
| Risk attribution (5-point scale: 1 = *strongly disagree*, 3 = *feeling neutral*, 5 = *strongly agree*) | 3.69 | 1.05 | In deciding whether or not to eat fish from Lake [Michigan] [Erie], I take into account whether I might be at risk from PCBs [polychlorinated biphenyls]. |
| Uncertainty judgment (11-point scale: 0 = none of this feeling to 10 = *a lot of this feeling*) | 5.38 | 3.08 | When you think about the possible *health risks posed to you* from eating Lake [Michigan] [Erie] fish, how much uncertainty do you feel? |
| Worry (11-point scale: 0 = *none of this feeling* to 10 = *a lot of this feeling*) | 4.45 | 3.26 | When you think about the possible *health risks posed to you* from eating Lake [Michigan] [Erie] fish, how much worry do you feel? |
| Anger (11-point scale: 0 = *none of this feeling* to 10 = *a lot of this feeling*) | 4.82 | 3.46 | When you think about the possible *health risks posed to you* from eating Lake [Michigan] [Erie] fish, how much anger do you feel? |
| Information insufficiency |  |  |  |
| Current knowledge | 38.65 | 22.67 | Now, we would like you to rate your knowledge about this risk. Please use a scale of 0 to 100, where 0 means *knowing nothing* and 100 means *knowing everything you could possibly know* about this topic. Using this scale, how much do you think you currently know about the risk from eating Lake [Michigan] [Erie] fish? |
| Sufficiency threshold | 66.29 | 22.12 | On a scale of 0 to 100, where 0 *means need to know nothing* and 100 *means need to know everything you could possibly know* to deal adequately with this risk in your life, how much knowledge would you *need* to deal adequately with the possible risk from eating Lake [Michigan] [Erie] fish in your own life? |
| Information-seeking behavior (5-point scale: 1 = *strongly disagree* to 5 = *strongly agree*) | 3.41 | 0.81 | (Item 1) When it comes to the risk from eating Lake [Michigan] [Erie] fish, I’m likely to go out of my way to get more information. |
|  |  |  | (Item 2) When the topic of risks from eating Lake [Michigan] [Erie] fish comes up, I try to learn more about it. |
| Attitude toward fish avoidance (5-point scale: 1 = *strongly disagree* to 5 = *strongly agree*) | 3.11 | 0.74 | For me to avoid eating fish from Lake [Michigan] [Erie], |
|  |  |  | (Item 1) would be a good thing to do. |
|  |  |  | (Item 2) would be beneficial for me. |
|  |  |  | (Item 3) would be a rewarding thing to do. |
|  |  |  | (Item 4) would be a useless thing to do. (reversed) |
| Fish avoidance intent (5-point scale: 1 = *strongly disagree* to 5 = *strongly agree*) | 2.88 | 1.14 | Given the opportunity to eat fish from Lake [Michigan] [Erie], |
|  |  |  | (Item 1) in the next few months, I would definitely avoid the fish. |
|  |  |  | (Item 2) next summer, I would definitely avoid the fish. |
| Fish avoidance behavior (the item was from the Wave 3 surveys; 3-point scale: 1= *not at all*, 2 = *once or twice*, 3 = *more than once or twice*) | 2.06 | 0.79 | This past summer, about how often did you eat fish caught in Lake [Michigan] [Erie]? This could be fish caught by an angler or purchased from a store or restaurant. Would you say not at all, once or twice, or more than once or twice? (reversed) |

*Risk attribution, uncertainty judgment, worry*, and *anger* were each measured by a single item (see Table 2 for details). The measure of *risk attribution* tapped into people’s perception that consumption of contaminated fish might be hazardous to them personally. The question asked the respondents to assess the extent to which they consider the behavior of eating fish from the Great Lakes to be a source of polychlorinated biphenyls–related harms.

*Uncertainty judgment* asked the respondents to indicate their degree of uncertainty when thinking about the possible risks to them posed by eating fish from the Great Lakes. To assess the affective responses, respondents were asked to indicate their levels of *worry* and *anger* when thinking about the potential risk to them posed by eating Great Lakes fish.

*Risk judgment* and *information insufficiency* were aggregate variables, and they were calculated as follows:

*Risk judgment* was created by multiplying respondents’ subjective appraisal of the probability of coming to harm with their appraisal of the severity of symptoms that could stem from consuming contaminated fish (see Table 2 for details).

Current knowledge and sufficiency threshold were used to construct the variable *information insufficiency*, which tapped into respondents’ perceptual gap between the information they possessed and the information they felt they needed to deal confidently with the risk of eating Great Lakes fish. To construct the *information insufficiency* variable, we used the residual approach (Cronbach & Furby, 1970) rather than the difference score approach (i.e., subtracting the current knowledge score from the sufficiency threshold score).3

Latent variables were *personal control*, governmental trust, information-seeking behavior, attitude toward fish avoidance, and fish avoidance intent. Three items were used to assess personal control by asking the respondents to indicate their ability to maintain control over the risk. *Governmental trust* was measured by three items that assessed respondents’ trust in the government to manage the risk.

*Information-seeking behavior* was captured by two items assessing respondents’ behavior related to seeking information about eating Great Lakes fish. *Attitude toward fish avoidance* was measured by four items assessing respondents’ views about avoiding eating fish from the Great Lakes. *Fish avoidance intent* was captured by two items assessing respondents’ intentions to avoid eating Great Lakes fish.

In addition, control measures included individual characteristics and whether or not the respondent was given the opportunity to read an article about Great Lakes fishing (part of another aspect of the study not reported here). Individual characteristics included *education* (measured as educational attainment ranging from grade school to postgraduate), *annual household income, age, ethnicity* (minority group; 0 = *no*, 1 = *yes*), gender (1 = *male*, 2 = *female*), *political conservatism* (measured on a 5-point scale ranging from 1 being *liberal* to 5 being *conservative*), and *experience with food-borne illness* (measured on a dichotomous scale whether or not the respondent had ever suffered from food poisoning; 0 = *no*, 1 = *yes*).

# Results

## Analysis

Using maximum likelihood estimation with robust standard errors in Mplus 6.11, we examined the paths and statistical fit of the measurement model, followed by the full structural model. Missing data for all variables (less than 1%) were handled by listwise deletion. Governmental trust, personal control, attitude toward fish avoidance, information seeking, and fish avoidance intent were measured as latent constructs, while perceived threat to future generations, risk attribution, uncertainty, worry, and anger were treated as single-item, observed variables. Risk judgment and information insufficiency were each treated as observed variables by fixing the error variance at zero. Individual characteristics and whether a person read the Great Lakes fishing article were controlled in the measurement and structural models, using the residual approach (Stephenson & Palmgreen, 2001). In addition, we added a residual correlation between worry and anger because both are affective responses to the health risk.

The measurement model indicated that the data achieved a good fit,4,5 comparative fit index (CFI) = 1.0, standardized root mean square residual (SRMR) = 0.03, root mean square error of approximation (RMSEA) = 0.01, 90% confidence interval [CI: .00, .03], χ2(67, *N* = 334) = 67.92, *p* = .45, and the structural model achieved an adequate fit, CFI = .92, RMSEA = 0.06, 90% CI [.05, .07], χ2(179, *N* = 334) = 378.47, χ2/degrees of freedom = 2.11, *p* < .001, SRMR = 0.10. The structural model is shown in Figure 2. We employ one-tailed tests to test directional hypotheses testing and two-tailed tests to answer our research questions (Hayes, 2009).

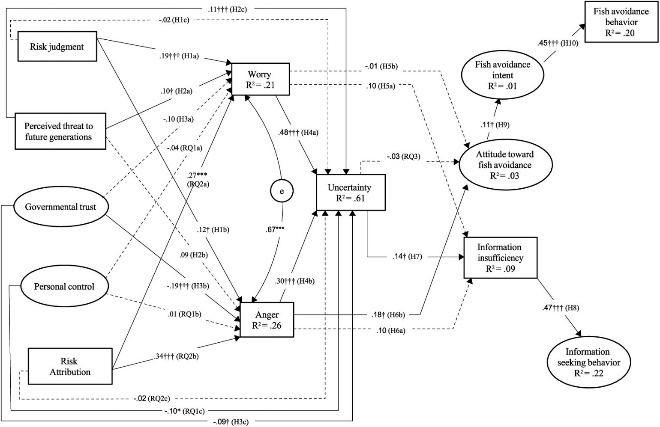


Figure 2. Structural model.

Note: H = hypothesis; RQ = research question. N = 334. “e” stands for correlation between error terms. The solid lines represent significant paths whereas the dotted lines represent nonsignificant paths.

\*p < .05. \*\*p < .01. \*\*\*p < .001, two-tailed test. †p < .05. ††p < .01, †††p < .001, one-tailed test.

## Hypotheses and Research Questions

### Worry With Perceived Hazard Characteristics

H1a and H2a predicted that risk judgment and perceived threat to future generations, respectively, would be positively related to worry. The data support both H1a (β = .19, *p* < .001) and H2a (β = .10, *p* < .05). That is, people were more inclined to worry when they perceived greater personal risk and greater risk to future generations from eating Great Lakes fish. RQ2a asked about the relationship between risk attribution and worry. Results showed that respondents, when deciding whether to eat Great Lakes fish, were more likely to worry if they considered the impact of fish consumption on their health (β = .27, *p* < .001).

H3a predicted a negative relationship between governmental trust and worry. However, governmental trust (β = −.10, *n.s*.) was not related to worry, so H3a was not supported. RQ1a asked about the relationship between personal control and worry. We found that personal control (β = −.04, *n.s*.) was not associated with worry.

### Anger With Perceived Hazard Characteristics

H1b posited that risk judgment would be positively related to anger. The data supported H1b (β = .12, *p* < .05), suggesting that people felt angrier when they perceived a greater level of personal risk from eating contaminated fish from the Great Lakes.

H3b postulated a negative relationship between governmental trust and anger. Governmental trust (β = −.19, *p* < .001) was indeed significantly and negatively associated with anger, so H3b was supported. Individuals were more likely to feel angry when they felt less trusting of government’s ability to protect them from the risks of eating contaminated Great Lakes fish.

RQ2b queried the relationship between risk attribution and anger. Risk attribution and anger were positively related (β = .34, *p* < .001), suggesting that respondents felt angrier when they perceived a clearer causal link between their health and eating fish.

H2b posited that perceived threat to future generations would be positively related to anger. However, that was not the case (β = .09, *n.s*.). RQ1b asked about the relationship between personal control and anger; we found that personal control (β = .01, *n.s.*) and anger were not related.

### Uncertainty With Perceived Hazard Characteristics

Hypotheses 1c and 2c predicted that risk judgment and perceived threat to future generations, respectively, would be positively related to uncertainty judgments. H3c postulated a negative relationship between governmental trust and uncertainty judgments. Contrary to H1c, risk judgment (β = −.02, *n.s*.) was not related to uncertainty. However, perceived threat to future generations (β = .11, *p* < .001) and governmental trust (β = −.09, *p* < .05) were significantly associated with uncertainty in the expected directions, supporting H2c and H3c. The findings suggest that individuals were more likely to perceive uncertainty about the potential health risks when they were less trusting of government or when they perceived a greater risk to future generations. Unexpectedly, perceived risk to oneself did not predict to uncertainty.

RQ1c and RQ2c examined the associations of personal control and risk attribution with uncertainty. The results indicate that personal control (β = −.10, *p* < .05) was negatively related to perceived uncertainty, suggesting that respondents who perceived less control over the risk tended to have greater uncertainty about the risk. However, risk attribution and uncertainty were unrelated (β = −.02, *n.s*.).

### Worry, Anger, and Uncertainty

H4a and 4b postulated that both worry and anger would be positively related to uncertainty. Both worry (β = .48, *p* < .001) and anger (β = .30, *p* < .001) were indeed significantly associated with uncertainty judgments, suggesting that people tended to perceive greater uncertainty when they felt more negative affect.

### Information Insufficiency With Worry, Anger, and Uncertainty

H5a, H6a, and H7 postulated that worry, anger, and uncertainty would be positively associated with information insufficiency. A significant positive relationship between uncertainty and information insufficiency was observed (β = .14, *p* < .05), suggesting that people tended to sense a greater need for information when they were uncertain about the risk. However, neither worry (β = .10, *n.s.*) nor anger (β = .10, *n.s.*) was related to information insufficiency.

### Attitude Toward Fish Avoidance With Worry, Anger, and Uncertainty

H6b proposed that anger would be positively associated with attitude toward fish avoidance. This turned out to be the case (β = .18, *p* < .05). People who felt angrier about the presence of contamination in fish from the Great Lakes were more likely to value avoiding those fish.

H5b proposed a positive relationship between worry and attitudes toward fish avoidance, while RQ3 asked about the relationship between uncertainty and attitudes toward fish avoidance. The findings, however, showed that neither worry (β = −.01, *n.s.*) nor uncertainty (β = −.03, *n.s.*) were related to attitude toward fish avoidance.

### Information Insufficiency and Information-Seeking Behavior

H8 postulated that information insufficiency would be positively associated with information-seeking behavior. Analysis revealed that information insufficiency (β = .47, *p* < .001) and information-seeking behavior were indeed positively related, suggesting that people who perceived a greater need for information to deal adequately with the health risks were likely to express a greater intention to seek information about those risks.

### Attitude Toward Fish Avoidance, Fish Avoidance Intent, and Fish Avoidance Behavior

H9, which predicted a positive relationship between attitudes toward fish avoidance and fish avoidance intent, was supported (β = .11, *p* < .05). Individuals who felt more strongly about avoiding fish consumption from the Great Lakes indicated greater behavioral intentions to do so. H10 predicted a positive association between fish avoidance intent and subsequent fish avoidance behavior. The hypothesis was supported (β = .45, *p* < .001), suggesting that people who expressed a greater intention to avoid the fish from the Great Lakes were indeed more likely to report eating less fish a year later. Figure 2 illustrates the structural model stemming from these tests.

### Additional Mediation Analyses

One unanticipated finding was that worry and anger had no direct, significant influence on information insufficiency. That led us to investigate whether the effect of worry and anger on information insufficiency and attitude toward fish avoidance might be fully mediated by uncertainty judgments. Table 3 presents the direct and indirect effects.

**Table 3**. Direct and Indirect Effect of Worry and Anger on Information Insufficiency and Attitude Toward Fish Avoidance.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **Information insufficiency** |  | **Attitude toward fish avoidance** |  |
|  | **Worry (β)** | **Anger (β)** | **Worry (β)** | **Anger (β)** |
| Total effect | .17† | .14† | −.00 | .16† |
| Direct effect | .10 | .10 | .02 | .17† |
| Indirect effect via uncertainty | .07† | .04† | −.02 | −.01 |

Note: β denotes standardized beta. *N* = 334.

\**p* < .05. \*\**p* < .01. \*\*\**p* < .001, two-tailed test. †*p* < .05. ††*p* < .01. †††*p* < .001, one-tailed test.

The findings indicate that the effect of worry on information insufficiency is indeed fully mediated by uncertainty judgments (β = .07, *p* < .05), as is the effect of anger on information insufficiency (β = .04, *p* < .05). However, the indirect effects of worry and anger on attitude toward fish avoidance via uncertainty judgment were not significant (worry: β = −.02, *n.s*.; anger: β = .07, *n.s.*). In short, both worry and anger seem to have influenced information insufficiency via uncertainty judgments. That is, anger and worry seem to have boosted perceptions of uncertainty, which in turn generated a greater need for information (i.e., information insufficiency) and subsequent information-seeking behavior. Anger had a direct influence on attitude toward fish avoidance, but worry remained unrelated to attitude toward fish avoidance, either directly or indirectly.

# Discussion

Using the RISP model, this study set out to investigate the relationships among affective responses toward the risk of eating contaminated fish, uncertainty judgments about that risk, attitudes toward health behaviors that would minimize the risk, and reported behaviors themselves. To do so, we used a longitudinal data set collected by Griffin et al. (1999) between 1996 and 1999 for secondary analysis. A major difference between the previous studies using the same dataset and this current study is that we utilized a subset of variables from the RISP model and added uncertainty judgment as a separate variable to examine its relationship with affective responses and their influences on health-related behavioral responses. As a result, this study provides a clearer understanding of the role of uncertainty judgments relative to affective attitudes and subsequent behavioral responses.

Using data collected nearly 20 years ago is always a concern. However, this study is a theory-building effort, freeing it to some extent from the strictures levied by the need for data currency. Although risk issues and behaviors will change over time, the conceptual links between affective responses to risks and perceptions of the uncertainty of those risks should remain fairly stable. An understanding of those links is important not only to risk communication scholars, who will continue to advance our understanding, but also to risk managers, who will encounter uncertainty perceptions and emotional reactions across an array of risks. Additionally, the ability to explore the causal link between a behavioral intention (to avoid fish) and actual behavior a year later makes this data set unique.

An overarching finding in this study is that uncertainty plays a central role in the RISP model. Our analysis revealed that perceived threat to future generations, personal control, and governmental trust influenced uncertainty, which in turn had an impact on information insufficiency. That is, people’s uncertainty judgments about the risk of eating contaminated fish from the Great Lakes seem to have been influenced by the extent to which they felt they had personal control, their level of trust in government, and their perceptions of threat to future generations. Our findings also showed that the more worried and angry people felt about the risk, the more they perceived that risk as uncertain. This strong association between emotions and uncertainty judgments supports the feelings-as-information hypothesis (Schwarz, 2010). Furthermore, our analysis also showed that the total effect of uncertainty judgment on information-seeking behavior was significant (β = .07, *p* < .05, one-tailed test). This represents the total change in information-seeking behavior for every one-unit change in uncertainty judgment via information insufficiency. Taking these findings together, the centrality of uncertainty as a factor in this study is striking.

This examination of the relationship between uncertainty and information insufficiency (see Figure 2) also contributes to the advancement of the RISP model. As defined in this study, uncertainty judgment refers to individuals’ subjective appraisal of the ambiguity, complexity, and unpredictability of a risk. On the other hand, judgmental confidence in the heuristic-systematic model is part of, and indirectly operationalized by, the information insufficiency variable in the RISP model. As shown in our findings, uncertainty judgments about a health risk and level of information insufficiency are significantly related, but uncertainty judgment taps into only some aspects of judgmental confidence in the information insufficiency concept. Although these two variables are related, they are not synonymous. They are only moderately correlated, *r* = .35, *p* < .001, and uncertainty judgment explained less than 10% of the variance in information insufficiency. Our findings suggest that uncertainty judgment is an important variable that should be treated separately in the RISP model. Other factors in the model, such as informational subjective norms, as well as individuals’ tolerance of uncertainty and their ability to adapt to uncertainty, both emphasized in uncertainty management theory (Bradac, 2001), may also influence information insufficiency.

Another important theoretical contribution to the RISP model stemming from this study is an exploration of the influence of negative affective states on attitudes toward a risk-related behavior (see Figure 2). Our findings revealed that anger and worry seemed to have influenced attitudes differently. Specifically, anger—but not worry—had a significant direct and positive impact on attitude toward fish avoidance. People who expressed more anger about the risk of consuming contaminated Great Lakes fish were more likely to indicate a greater likelihood of avoiding fish, a finding consistent with the literature. However, neither worry nor anger was directly related to information insufficiency. The influence of these two affective states on information insufficiency was indirect, through uncertainty judgments.

The lack of a relationship between worry and attitude toward fish avoidance is an interesting finding given the ubiquity of the use of “worry” and its analogs in risk communication studies. One possible explanation is that worry is a different type of emotion. Bohm and Pfister (2000) argued that worry is a prospective, loss-based emotion, resulting from subjective anticipation of future negative events causing loss, harm, and danger. Risk studies have shown that prospective, loss-based emotions are more likely to motivate people to actively engage in preventive behaviors such as taking actions to reduce or mitigate the potential harmful consequences and to improve the situation. For example, Robinson and Clore (2001) showed that worry was associated with anticipated effortful coping strategies. One could argue that the behavioral intention we chose—avoiding fish—is a more passive behavior and, thus, less likely to be aligned with worry than more active behaviors such as information seeking or preparing fish in ways that minimize the presence of contaminants.

A unique design element of this current analysis was our ability to add a yearlong time lag between fish avoidance intention and fish avoidance behavior, thanks to the longitudinal nature of the original study. This enabled us to reflect on causality in our assessment of the link between the intent to perform a health behavior and reported behavior. Our finding shows a strong association between the two. That is, respondents’ intention to avoid fish from the Great Lakes was strongly related to their actual fish avoidance behavior a year later. This finding provides an empirical addition to the causal link between behavioral intention and actual behavior in the RISP model.

Our findings also provide useful insights into the differential influence of perceived hazard characteristics on these affective responses to the health risk. Risk judgment had a significant and positive impact on both worry and anger, but it did not relate to uncertainty. Although respondents may perceive eating contaminated fish from the Great Lakes region as a low-level risk (*M* = 18.99 on a scale of 0 to 100, *SD* = 22.43) and this perceived low-level risk generates relatively low levels of worry, those worry levels do influence uncertainty. It appears that a person needs to make the link between risk judgment and worry before the dyad affects uncertainty perceptions.

Consistent with the literature, risk attribution was also positively related to both worry and anger. However, while perceived threat to future generations had a significant positive impact on worry, its impact on anger was negligible. Conversely, governmental trust was negatively related to anger but played a negligible role in worry. When pondering the behavior of “responsible” agencies, people may react to perceived negligence with more moral emotions, such as anger. These differences between anger and worry remind us that affective emotions, even when on the same side of the valence continuum (negative in this case), can have conceptually distinct impacts on attitudes and behavior.

Risk attribution, defined as the extent to which individuals think about whether eating the contaminated fish could potentially cause them to become ill, was related to both worry and anger, suggesting that risk attribution affects emotions at both individual (worry) and societal (anger) levels. In other words, among local residents who expected to become ill from eating contaminated Great Lakes fish, we found not only a heightened sense of individual worry but also increased levels of anger toward agencies in charge of managing risks at a societal level. Future research could profitably examine risk attribution as a form of outcome expectancy and its effect on variables in the RISP model. Further studies might also explore internal and external risk attributions.

In addition to enhancing our theoretical understanding of risk communication processes, our results have some practical implications. Many health risk managers try to minimize communication of uncertainty, but this study suggests that making uncertainty a substantive part of a risk message may be the better strategy. Helping audiences understand the extent of uncertainty about a health risk may help worried individuals to perceive a greater need for information about the risk, which in turn may prompt them to seek out more information. In the case of Great Lakes fish consumption advisories, for example, risk communicators might emphasize the risk’s complexity by drawing the audience’s attention to factors that influence the effects of consuming contaminated fish on themselves and on future generations. Such intervening factors may include the level of contaminants in different sizes and species of fish, the *incubation* period of different contaminants, and the ways in which individuals may react—both biologically and psychologically—to the contaminants. That said, it will be important for future research to explore how audiences understand the uncertainty inherent in risks, as our study did not differentiate among such uncertainty dimensions as ambiguity, complexity, or unpredictability. Additionally, audience characteristics such as level of education may lead to differential reactions.

Similarly, risk communicators may want to consider valuing—rather than trying to avoid—audiences’ affective responses to a risk. As shown in our findings, anger stemming from the risk of consuming contaminated fish from the Great Lakes was associated with a positive attitude toward fish avoidance. According to Turner’s anger activism model (Turner, 2007), people who feel moderately angry about a health risk and who experience high levels of efficacy are more intent on engaging in strategies to cope with risky situations. Therefore, as suggested by Turner, carefully crafted risk messages that anticipate moderate levels of anger and that foster individuals’ self-efficacy may encourage people to take actions to address the risk.

It is important to consider the limitations of this study. First, because this was a secondary analysis, we were restricted to single-item measures for some constructs (e.g., perceived threat to future generations, specific affective responses). Furthermore, the measure of uncertainty judgment, one of the key variables in this study, was also a single item, and we were unable to fully assess the uncertainty-related dimensions of ambiguity, complexity, or unpredictability. Future research may seek to measure these constructs in a more comprehensive way. And while the theory-building components of this study are, we think, of value, the data focus on only one risk. These affect/uncertainty/behavior patterns need to be replicated using other risk issues.

This study provides some other suggestions for subsequent research. As noted earlier, other factors may also influence information insufficiency. Examining the constructs important to uncertainty management, problematic integration, and uncertainty reduction theories (Bradac, 2001) within the framework of RISP may have merit. Furthermore, individuals’ tolerance of uncertainty may also play an important role in information insufficiency. Studies that can examine the interplay of both individual and societal factors in the construction of uncertainty perceptions will be useful next steps in this risk communication domain. Finally, the RISP model (Griffin et al., 1999) proposes that information processing—especially systematic processing—should relate positively to the stability of attitude toward the behavior, behavioral intention, and actual behavior over time. More scholars need to employ longitudinal data in service to exploring those factors.

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# Footnotes

1. In this three-wave, panel-design, telephone sample survey, the residences were chosen by random digit dialing from two cities situated on the shores of the Great Lakes: Milwaukee, Wisconsin, on Lake Michigan, and Cleveland, Ohio, on Lake Erie, and the respondents were selected randomly within households. For the details of the sampling procedures and the sample sizes of each wave in the panel study, please refer to Kahlor, Dunwoody, Griffin, Neuwirth, and Giese (2003). The sample characteristics can be provided upon request. A subset (*N* = 166) of the 356 respondents in Wave 3 of the panel survey was randomly chosen to receive a magazine-like article about the health of the Great Lakes and its fish (i.e., information catalyst). The primary goal of the information catalyst was to examine information processing strategies. Given that this is not the foci of the current study, the *information catalyst* was included as control variable (0 = *did not receive the information catalyst*, 1 = *received the information catalyst and read it*). Respondents who received the information catalyst but did not read it were excluded from this analysis (*n* = 22) because these respondents were not required to answer some items in the wave three surveys. Therefore, 334 respondents in all were included in this study.

2. We used data from the Wave 2 and Wave 3 surveys for analysis because the Wave 1 survey contained no measures related to TPB (e.g., fish avoidance intention and fish avoidance behavior). The only place in the entire three-wave panel surveys where we have the chance to see whether behavioral intention predicts future behavior is from behavioral intention in Wave 2 surveys and the actual behavior in Wave 3 surveys.

3. The difference score approach suffers from the problems of a high correlation between current knowledge and difference scores and measurement errors (Bergh & Fairbank, 2002). In the residual approach, current knowledge was entered into the regression equation as a predictor of the sufficiency threshold, and the predicted value was saved as the unstandardized residual. As such, the variance accounted for by current knowledge was removed from the information sufficiency threshold. The unstandardized residual then served as the information insufficiency variable.

4. According to guidelines for adequate and/or acceptable mode fit (Holbert & Stephenson, 2002; Hu & Bentler, 1995), a value of the root mean square error of approximation (RMSEA) below .06 is considered a good fit, and a value less than or equal to .08 indicates an adequate fit with the upper bound of the 90% RMSEA confidence interval less than .10. A value of comparative fit index greater than .90 indicates an adequate fit, and a value greater than .95 suggests a good fit. The value of a standardized root mean squared residual of less than .08 is considered acceptable. A nonsignificant chi-square distributed test statistic is considered a good fit; however, this statistic is sensitive to sample size (Hu & Bentler, 1995). Therefore, the χ2/degrees of greedom was also reported where a value less than five suggested a good fit (Kline, 2005).

5. The factor loading of the three items of personal control were as follows: Item 1 = .83\*\*\*, Item 2 = .80\*\*\*, Item 3 = .77\*\*\*. The factor loading of the three items of governmental trust were as follows: Item 1 = .72\*\*\*, Item 2 = .78\*\*\*, Item 3 = .64\*\*\*. The factor loading of the four items of attitude toward fish avoidance were as follows: Item 1 = .88\*\*\*, Item 2 = .81\*\*\*, Item 3 = .71\*\*\*, Item 4 = .49\*\*\*. The factor loading of the two items of fish avoidance intention were as follows: Item 1: .98\*\*\*, Item 2 = .92\*\*\*. The factor loading of the two items of information seeking were as follows: Item 1: .86\*, Item 2: .60\*. For the specific items of each variable, please refer to Table 2.

# References

Ajzen I. (1991). The theory of planned behavior. Organizational Behavior and Human Decision Processes, 50, 179-211.

American Sportfishing Association. (2013). Sport fishing in America. Retrieved from http://asafishing.org/uploads/2011\_ASASportfishing\_in\_America\_Report\_January\_2013.pdf

Anderson A., Falk C., Hanrahan L., Olson J., Burse V., Needham L., . . . Hill R. (1998). Profiles of Great Lakes critical pollutants: A sentinel analysis of human blood and urine. Environmental Health Perspective, 106, 279-289.

Baron J., Hershey J. C., Kunreuther H. (2000). Determinants of priority for risk reduction: The role of worry. Risk Analysis, 20, 413-427.

Bergh D., Fairbank J. F. (2002). Measuring and testing change in strategic management research. Strategic Management Journal, 23, 359-366.

Bohm G., Pfister H. R. (2000). Action tendencies and characteristics of environmental risks. Acta Psychologica, 104, 317-337.

Bradac J. J. (2001). Theory comparison: Uncertainty reduction, problematic integration, uncertainty management, and other curious constructs. Journal of Communication, 51, 456-476.

Brashers D. E. (2001). Communication and uncertainty management. Journal of Communication, 51, 477-497.

Castro-González M. I., Méndez-Armenta M. (2008). Heavy metals: Implications associated to fish consumption. Environmental Toxicology and Pharmacology, 26, 263-271.

Clore G. L., Schnall S. (2005). The influence of affect on attitude. In Albarracín D., Johnson B. T., Zanna M. P. (Eds.), Handbook of attitudes (pp. 437-489). Mahwah, NJ: Lawrence Erlbaum.

Conner M., Armitage C. (1998). Extending the theory of planned behavior: A review and avenues for further research. Journal of Applied Social Psychology, 28, 1429-1464.

Conner M., Sparks P. (2005). Theory of planned behavior and health behavior. In Conner M., Norman P. (Eds.), Predicting health behavior (2nd ed.) (pp. 170-222). Buckingham, England: Open University Press.

Cronbach L. J., Furby L. (1970). How should measure “change”—or should we? Psychological Bulletin, 74, 68-80.

Cvetkovich G., Siegrist M., Murray R., Tragesser S. (2002). New information and social trust: Asymmetry and perseverance of attributions about hazard mangers. Risk Analysis, 22, 359-367.

Eagly A. H., Chaiken S. (1993). The psychology of attitudes. San Diego, CA: Harcourt Brace.

Griffin R. J., Dunwoody S., Neuwirth K. (1999). Proposed model of the relationship of risk information seeking and processing to the development of preventive behaviors. Environmental Research, 80(2 Pt. 2), S230-S245.

Griffin R. J., Neuwirth K., Dunwoody S., Giese J. (2004). Information sufficiency and risk communication. Media Psychology, 6, 23-61.

Griffin R. J., Neuwirth K., Giese J., Dunwoody S. (2002). Linking the heuristic-systematic model and depth of processing. Communication Research, 29, 705-732.

Griffin R. J., Yang Z., ter Huurne E., Boerner F., Ortiz S., Dunwoody S. (2008). After the flood: Anger, attribution, and the seeking of information. Science Communication, 29, 285-315.

Han P., Moser R., Klein W. (2006). Perceived ambiguity about cancer prevention recommendations: Relationship to perceptions of cancer preventability, risk and worry. Journal of Health Communication, 11, 51-69.

Hayes A. F. (2009). Statistical methods for communication science. New York, NY: Routledge.

Hogg M. A. (2000). Subjective uncertainty reduction through self-categorization: A motivational theory of social identity processes. European Review of Social Psychology, 11, 223-255.

Holbert R. L., Stephenson M. T. (2002). Structural equation modeling in the communication sciences, 1995-2000. Human Communication Research, 28, 531-551.

Hu L. T., Bentler P. M. (1995). Evaluating model fit. In Hoyle R. (Ed.), Structural equation modeling: Concepts, issues, and applications (pp. 76-99). Thousand Oaks, CA: Sage.

Hwang Y., Jeong S. H. (2016). Information insufficiency and information seeking: An experiment. Science Communication, 38, 679-698.

Imm P., Knobeloch L., Anderson H. A., & the Great Lakes Sport Fish Consortium. (2005). Fish consumption and advisory awareness in the Great Lakes Basin. Environmental Health Perspectives, 113, 1325-1329.

Johnson B., Slovic P. (1998). Lay views on uncertainty in environmental health risk assessment. Journal of Risk Research, 1, 261-279.

Kahlor L., Dunwoody S., Griffin R., Neuwirth K., Giese J. (2003). Studying heuristic-systematic processing of risk communication. Risk Analysis, 23, 355-368.

Kline R. B. (2005). Principles and practice of structural equation modeling (2nd ed.). New York, NY: Guilford Press.

Kuppens P., Van Mechelen I., Smits D. J., De Boeck P. (2003). The appraisal basis of anger: Specificity, necessity and sufficiency of components. Emotion, 3, 254-269.

McCaul K. D., Mullens A. B., Romanek K. M., Erickson S. C., Gatheridge B. J. (2007). The motivational effects of thinking and worrying about the effects of smoking cigarettes. Cognition and Emotion, 21, 1780-1798.

McEachan R. R. C., Conner M., Taylor N. J., Lawton R. J. (2011). Prospective prediction of health-related behaviours with the theory of planned behaviour: A meta-analysis. Health Psychology Review, 5, 97-144.

Mishel M. H. (1997). Uncertainty in acute illness. Annual Review of Nursing Research, 15, 57-80.

Powell M., Dunwoody S., Griffin R., Neuwirth K. (2007). Exploring lay uncertainty about an environmental health risk. Public Understanding of Science, 16, 323-343.

Robinson M., Clore G. (2001). Simulation, scenarios, and emotional appraisal: Testing the convergence of real and imagined reactions to emotional stimuli. Personality and Social Psychological Bulletin, 27(11), 1520-1532.

Schwarz N. (2010). Feelings-as-information theory. In Lange P. V., Kruglanski A., Higgins E. T. (Eds.), Handbook of theories of social psychology (pp.289-308). Thousand Oaks, CA: Sage.

Slovic P., Peters E., Finucane M. L., MacGregor D. G. (2005). Affect, risk, and decision making. Health Psychology, 24(4 Suppl.), S35-S40.

Smith C. A., Ellsworth P. C. (1985). Patterns of cognitive appraisal in emotion. Journal of Personality and Social Psychology, 48, 813-838.

Smith E. R., Kluegel J. R. (1982). Cognitive and social bases of emotional experience: Outcome, attribution, and affect. Journal of Personality and Social Psychology, 43, 1129-1141.

Stephenson M. T., Palmgreen P. (2001). Sensation seeking, perceived message sensation value, personal involvement, and processing of anti-marijuana PSAs. Communication Monographs, 68, 49-71.

Turner M. M. (2007). Using emotion in risk communication: The anger activism model. Public Relations Review, 33, 114-119.

Turyk M. E., Bhavsar S. P., Bowerman W., Boysen E., Clark M., Diamond M., . . . Carpenter D. O. (2012). Risks and benefits of consumption of Great Lakes fish. Environmental Health Perspectives, 120, 11-18.

Visschers V. (2017). Public perception of uncertainties within climate change science. Risk Analysis. Advance online publication.

Weary G., Edwards J. A. (1996). Causal-uncertainty beliefs and related goal structures. In Sorrentino R. M., Higgins E. T. (Eds.), Handbook of motivation and cognition: Vol. 3. The interpersonal context (pp. 148-181). New York, NY: Guilford Press.

Weisskopf M. G., Anderson H. A., Hanrahan L. P., Kanarek M. S., Falk C. M., Steenport D. M., . . . Great Lakes Consortium. (2005). Maternal exposure to Great Lakes sport-caught fish and dichlorodiphenyl dichloroethylene, but not polychlorinated biphenyls, is associated with reduced birth weight. Environmental Research, 97, 149-162.

Yang Z. J., Aloe A., Feeley T. (2014). Risk information seeking and processing model: A meta-analysis. Journal of Communication, 64, 20-41.

Yang Z. J., Kahlor L. (2013). What, me worry? The role of affect in information seeking and avoidance. Science Communication, 35, 189-212.