SIZING UP A SUPERSTORM: EXPLORING THE ROLE OF RECALLED EXPERIENCE AND ATTRIBUTION OF RESPONSIBILITY IN JUDGMENTS OF FUTURE HURRICANE RISK

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ABSTRACT

Research suggests that hurricane-related risk perception is a critical predictor of behavioral response, such as evacuation. Less is known, however, about the precursors of these subjective risk judgments, especially when time has elapsed from a focal event. Drawing broadly from the risk communication, social psychology, and natural hazards literature, and specifically from concepts adapted from the risk information seeking and processing model (RISP) and the protective action decision model (PADM), we examine how individuals' distant recollections, including attribution of responsibility for the effects of a storm, attitude toward relevant information, and past hurricane experience, relate to risk judgment for a future, similar event. The present study reports on a survey involving U.S. residents in Connecticut, New Jersey, and New York (N = 619) impacted by Hurricane Sandy. While some results confirm past findings, such as that hurricane experience increases risk judgment, others suggest additional complexity, such as how various types of experience (e.g., having evacuated vs. having experienced losses) may heighten *or* attenuate individual-level judgments of responsibility. We

suggest avenues for future research, as well as implications for federal agencies involved in severe weather/natural hazard forecasting and communication with public audiences.

Keywords

Risk perception, hurricane, attribution theory, risk information seeking and processing (RISP), protective action decision model (PADM)

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1. INTRODUCTION

From reports of flooded New York City subway tunnels to blizzard conditions in North Carolina, news of the devastating impacts of Hurricane Sandy[1] swept the nation in October 2012, as storm surge engulfed much of the U.S. East Coast. (1) While media outlets were saturated with tales of inadequate emergency management planning and images of failed infrastructure, other Hurricane Sandy stories – including how residents of affected locations perceived the risks of the storm – were less often told. Yet, past research suggests that hurricane-related risk perception can be central to predicting behavioral response, such as whether at-risk residents will choose to evacuate during a future storm. (2,3) As coastal communities face a likely future of increased severe storms and related risks (e.g., storm surge), (4) understanding residents' subjective risk perceptions becomes a necessary counterpart to managing objective risk.

In the present research, we delve more deeply into the predictors of hurricane-related risk judgment. Drawing from two seminal models in the risk communication and natural hazards literature, the risk information seeking and processing model (RISP), [5,6] and the protective action decision model (PADM), [7] respectively, we examine how individuals' perceptions, including attribution of responsibility, attitude toward information, and past experience, relate to risk judgment for a future, similar event. By considering more distant recollections – an individual's memory of a given storm, after some time has elapsed – we suggest that memories of past hurricane experiences may be as important as more immediate reactions in shaping perceptions of future events.

We report on a large-scale survey involving U.S. residents of Connecticut, New Jersey, and New York impacted by Hurricane Sandy, who completed a number of key measures related to their prior experience with hurricanes, attitude toward available information about the storm, and attribution of responsibility for the effects of the storm. While some results confirm past findings in the risk perception and natural hazards literature, such as that hurricane experience increases risk judgment, others suggest additional complexity, such as how various types of experience may heighten *or* attenuate individual-level judgments of responsibility, and attribution of responsibility may relate to risk judgment. Beyond the context of hurricanes, we suggest future research examining whether these relationships persist for natural hazards that are less time- and location-specific, such as those associated with climate change. We suggest avenues for future research, as well as implications for federal agencies involved in severe weather/natural hazard forecasting and response.

2. LITERATURE REVIEW

Rather than making risk assessments of weather or natural hazards based on objective criteria such as the location of their home, individuals often rely on subjective feelings, such as those based on past experience, to judge hazard-related risks, and to engage in decision-making.[2,3] In the case of coastal Texas residents affected by Hurricane Ike, for instance, Morss and Hayden (p. 180) [8] found

that, in addition to knowledge of the objective risk, "experience, evacuation orders, forecasts, environmental cues, household interactions, and resources and constraints" all contributed to individuals' decisions to evacuate. As Dash and Gladwin (p. 72) [2] note:

> Whether for those in an official evacuation zone with the expectation of leaving as a storm approaches or for 'shadow evacuators' who perceive personal danger despite not being in an evacuation zone, understanding how people decide that an event poses risk to themselves and family is critical to modeling evacuation behavior…

Following this lead, in the following sections, we explore several key variables that may influence the development of risk judgment in the context of hurricanes: (1) attitude toward available information; (2) prior experience with the hazard; (3) attribution of responsibility for the impacts of the hazard; and (4) sociodemographic characteristics. As we explain below, the study's theoretical grounding draws upon two seminal models in the risk communication and natural hazards literature: the RISP model, [5,6] and PADM, [7] respectively. Whereas the RISP model explains the precursors to engaging in thoughtful reflection (or searching for information) about a risk-related topic, PADM outlines predictors of participating in risk-preventive behavior (e.g., evacuation) in the face of a natural hazard event; concepts drawn from both models may allow us to better understand how hurricane-related risk judgments develop. Moreover, as explained below, we draw on social psychological literature on the role of retrospection in judgment and decision making and conceptualize these self-reports as "distant recollections" – measured some time after the individual's experience with the focal event (i.e., Hurricane Sandy) – rather than perceptions measured in the more immediate aftermath of the storm, as may be more typical in the hurricane risk perception and decision-making literature. [8-10]

2.1. Attitude toward Available Information

Past research in the natural hazards literature suggests that individuals rely on mass media, such as television broadcasts, for severe weather and natural hazard-related information. [8-12] In their study of Hurricane Ike survivors, Morss and Hayden (p. 183) [8] found that more than two-thirds of

respondents had relied on television for information about the storm, principally due to their perception of its "updated, round-the-clock, and convenient coverage, as well as the knowledge and information provided by trusted local broadcasters." In the context of PADM, Lindell and Perry [7] note that information sources, as well as information channel access and preference, can contribute indirectly to natural hazard-related risk perceptions and behavioral response. The importance of one's attitude toward communication sources is echoed in the risk communication literature, particularly, in the RISP model, where "relevant channel beliefs" have been conceptualized as "beliefs and evaluations about the outcomes of one's seeking and processing risk information from various channels" (p. 336). [6] In recent empirical applications of the RISP model in environmental contexts, relevant channel beliefs – assessed through items such as "learning about climate change is valuable" – have been found to influence information seeking and processing behaviors. [13,14]

Along with content, credibility – the extent to which sources, such as television stations, newspapers, or individuals are perceived as fair, unbiased, believable, and so on – is of paramount importance to attitudes and decision-making with respect to weather and natural hazards, and in risk-related contexts more generally. To better predict hazard-related behaviors, Lindell and Perry [7] highlight the need to understand perceived trustworthiness and expertise associated with a given information source in the context of a natural hazard event. Among South Florida residents who experienced Hurricane Andrew, for instance, television broadcasts of hurricane-related information were judged more credible than other sources, such as friends or neighbors, leading individuals to rely on television for the provision of "factual" information. [11] Other research in risk communication has linked source credibility with perception of relevant risk, suggesting that as credibility of the actor or news outlet reporting on a given risk increases, perceived risk decreases. [15, 16] Indeed, the original conception of " relevant channel beliefs" in the RISP model – and its application in early studies in risk communication – focused on the perceived "trustworthiness" and "usefulness" of information, and its relevance for information seeking and processing. [5,6] In the present study, we examine how

individuals' awareness of the Hurricane Sandy forecast prior to the storm (specifically, its projected severity for their area), and source credibility (specifically, with respect to various television outlets) relate to attitudes toward relevant information. Our first hypothesis states:

H1: Awareness of the Hurricane Sandy forecast (**H1a)** and perceived credibility of mass media sources (**H1b**) will be positively related to attitude toward hurricane information.

2.2. Recollection and Experience

Recent research focuses on the role that directly experiencing a severe weather or natural hazard event can play in increasing issue salience and understanding, risk judgment, and related behavioral intentions. [3,7, 17-20] This work complements the sizable psychological literature on the role of past experiences in anticipated reactions to future events. [21-23] As Gilbert and Wilson (p. 1352) [21] put it, "Memories are the building blocks of simulations": when people are asked to anticipate their affective response to some possible future event—whether that is sleeping in on a Saturday morning, moving to sunny California, [24] or experiencing another hurricane event—neuroscience evidence suggests that the same brain regions that are activated in memory (or retrospection) are also active in imaging future states (or prospection). [23,25]

Not only does psychological research suggest that recalled experiences guide judgments about one's affective response about a similar future event (affective forecasts) and behavioral intentions, but the sizable literature describing systematic biases in human memory [26] also suggests that one's subjective *recollections* of experiences are often a more powerful determinant of future actions than are the objective reality of the experiences themselves. For example, in an empirical demonstration comparing real-time and retrospective pain reports among patients undergoing colonoscopy, recalled pain was more strongly associated with the "peak" amount recorded in real-time (i.e., how bad it got) and with that registered during the final minutes of procedure (i.e., how it ended) than with total duration of the procedure, suggesting that intense and recent experiences dominate recall.[27] In a

follow-up randomized controlled trial, colonoscopy patients who were assigned to undergo the standard procedure or an elongated procedure with a less painful ending. Patients in the treatment condition (who experienced the longer procedure) not only recalled their experience as less unpleasant, but also were substantially more likely to return for their follow-up appointment approximately five years later, relative to those who experienced the standard, shorter procedure (which registered less pain on real-time reports).[28] These findings suggest that because decisions about future actions are made on recollections of (versus actual) past experiences, investigating the role of recalled experiences—even those assessed after significant time has elapsed between the event and the moment of recall—can be useful for modeling reactions to future, similar events.

Indeed, with regard to judgments about risk of a future hurricane event, the "recency, frequency, and intensity" (p. 620) [7] of one's past experiences matter – and can be felt directly, or indirectly, such as through the experiences of family, friends, neighbors, or co-workers. Research suggests that when a hurricane makes landfall near one's home – and/or if an individual, or a close other, experiences personal losses (such as property damage) – risk judgment tends to increase with respect to experiencing future events. [29] Among individuals living adjacent to the U.S. Gulf Coast, for example, having less past experience with hurricanes in general, as well as less direct experience of Hurricanes Rita and Katrina, depressed hurricane-related risk perceptions. [30]

While perceiving more risk based on one's past experience is evident in the studies reviewed above, other research characterizes the relationship between past experience and risk perception of severe weather or natural hazards as more mixed. In a meta-analysis of studies examining the relationship between natural hazards (e.g., floods, earthquakes, volcanic eruptions), risk perception, and preventive behavior, Wachinger et al. [20] provide examples where past experience can either intensify or dampen risk perception, as well as lead to over- or under-estimating future impacts. In the context of a hurricane, the nature of one's past personal experience, including the severity of the impacts (e.g., did it constitute a "near miss" for the individual's local area?), [10] and the quality of

one's evacuation experience (Sharma & Patt, 2012), may matter for determining risk perception and future behaviors. In this vein, Demuth, Morss, Lazo, and Trumbo [31] show that, among Miami-Dade county (Florida) residents in coastal areas at high risk for hurricanes, certain types of hurricane-related experience, such as financial loss, increased negative affect, and, in turn, evacuation intention with respect to a hypothetical hurricane. Other experiences, such as emotional impact, however, decreased self-efficacy and, in turn, evacuation intention. As Peacock et al. (p. 123) [29] conclude, "All experience may not be equal with respect to risk perception."

Finally, risk judgment may change over time, especially as the distance between the present and one's experience with the weather or natural hazard-related risk increases. [20] For instance, in a longitudinal study of Gulf Coast residents, hurricane-related risk perception decreased over time while optimistic bias – i.e., perceiving the risk posed to others as greater than risk to self – increased; [32] however, in a longitudinal study of homeowners in Colorado, Champ and Brenkert-Smith [33] show that perceptions of wildfire risk remained relatively stable, despite intervening wildfire in the area. While recall accuracy for past events is likely to diminish over time, opening the way for a host of biased judgments in general, self-reported assessments of risk are likely to vary across individuals and contexts given the reconstructive nature of memory and the largely heuristic (versus systematic) nature of the inferential processes that guide cognitive retrieval and reporting. Thus, individuals may remember the same event differently and, in turn, experience different affective reactions to imaging a similar event occurring in the future [34,35] –further underscoring the importance of better understanding the role of subjective, recalled experiences in assessments of the risk posed by a similar, future event. The multiple possible effects of experience on risk perception evident in the weather and natural hazards literature reviewed above lead us to pose the following research question:

> **RQ1:** What is the relationship between an individual's recollection of past hurricane experience in general (**RQ1a**) and during Hurricane Sandy specifically (**RQ1b**) to risk judgment about a future hurricane event?

2.3. Attribution of Responsibility

When a neighborhood floods or a hurricane strikes, individuals' attitudes and behavioral decisions may be related, in part, to who (or what) they see as responsible for preventing – or responding to – associated damage: the individual him/herself, and/or outside actors, such as government officials. [36,37] Research on attributing responsibility for responding to a weather or natural hazard event and individuals' related risk judgment is apparent in multiple literatures, including risk communication (and the RISP model more specifically), [38] natural resource management, [39,40] and political science. [41] Much social psychological attribution research distinguishes the locus of causality of a given event as internal ("dispositional"), those presumably brought about by actions or characteristics of the individual, or external ("situational), forces outside of the person. [42] In the natural hazards literature, including in the PADM, the concept of *protection responsibility* describes the perceived responsibility for adopting preventive measures to ensure safety during a hazard event, whether attributed to an individual or to an outside actor (e.g., government agency), and is often associated with behavior [39,7]; namely, the more an individual views oneself as responsible for protecting oneself from harm, the more likely s/he is to engage in preventive behaviors. Focusing centrally on earthquake risk, natural hazard researchers have shown that individuals living in seismic zones may perceive *both* themselves and external actors as responsible, in part, for preventing earthquake-related risk. For instance, in a survey of California students, Lindell and Whitney [36] found that, among a list of "official" actors provided (e.g., federal government, university), respondents rated state government as most responsible for seismic protection, and, among the "informal" actors (e.g., friends, family), respondents rated themselves as most responsible. Moreover, how individuals attribute responsibility for damages caused by a natural hazard may also depend on their perceived ability to enact the suggested behaviors. [43, 44] Attribution of responsibility may also vary by gender, as shown in a survey of Southern California residents, where women assigned more "equal" attributions of seismic protection responsibility to various internal and external

actor categories (e.g., self/family, authorities), on average, than did men. [45]

Portrayal of events in the mass media may also affect how individuals form attributions of responsibility related to these events, [46] but studies in the context of weather and natural hazards are limited. In an experimental study, Ben-Porath and Shaker [47] show that providing images of Hurricane Katrina victims influenced how respondents attributed responsibility to the government for the impacts of the storm, though this effect was contingent on race. A handful of media content analysis studies suggest a relationship between newspaper coverage of natural hazard events, such as earthquakes, and public perceptions of the preventability of such events. [48-50] For instance, McClure et al. [47] show that New Zealand newspaper media coverage of earthquakes tended to overemphasize the sheer *magnitude* of the event (e.g., an entire neighborhood destroyed) rather than the *distinctiveness* of the damage (e.g., a particular house damaged), which could lead the public to perceive the damage as uncontrollable, and thus to downplay its preventability.

Rather than examine particular effects of message framing on attribution of responsibility, or the specific content of individual news sources, the present study explores a more general relationship between attitude toward hurricane information, a foundational concept in the RISP model – such as that learning about hurricanes is important – and attribution of responsibility – such as that individual citizens as responsible for the negative impacts of Hurricane Sandy. Given the lack of clear research precedent, we pose a research question:

RQ2: What is the relationship between attitude toward information and internal attribution of responsibility?

Whereas protection responsibility most often describes how individuals see themselves (or others) as responsible for preventing natural hazard risk, other social psychological research has described ways in which individuals may defer responsibility in order to protect their self-interest. [42,51] Studies describing this "defensive attribution" [52] response suggest that, under certain conditions,

personal experience – including having suffered consequences from the event or a similar event – may lead an individual to be *less* likely to blame oneself (or similar others), and more likely to hold external actors as responsible for negative consequences. [42,53, 54] Moreover, these self-serving attributions may be related to risk perception [38,55,56] In a California community affected by wildfire, individuals who had experienced wildfires in the past were more likely to attribute responsibility for the fire damage to people other than themselves, such as government agencies, firefighters, and bureaucrats [40,57,58] Likewise, in a study of the effects of Tropical Storm Allison on voting behavior in a mayoral election, Arceneaux and Stein [59] found that Houston residents who suffered storm damage were more likely to blame the government for inadequate flood prevention measures. Motivated by studies illustrating the relationship between personal experience and defensive attribution, we hypothesize:

H2: There will be a negative relationship between internal attribution of responsibility (i.e., ascribing responsibility to an individual citizen for the negative consequences of Hurricane Sandy) and: general past experience with hurricanes (**H2a**); specific Hurricane Sandy experience (**H2b**); having evacuated during Hurricane Sandy (**H2c**).

Studies examining a waterborne disease outbreak, [55] flooding in an urban watershed, [38] and visitor injury in national parks [56] have also suggested a link between defensive attribution and risk judgment; however, a lack of consistent measurement across these studies, and the cross-sectional nature of the data make it difficult to draw conclusions about the relationship between these variables. Moreover, questions remain as to causal ordering: that is, does risk judgment lead to defensive attribution, or does eschewing individual responsibility affect perception of risk? In light of this uncertainty, we pose the following research question:

RQ3: What is the relationship between internal attribution of responsibility and risk judgment?

2.4. Individual Characteristics

There is some evidence to suggest that risk perception of severe weather or natural hazard events may be related to sociodemographic characteristics. [18] Echoing findings on the "white male effect" in the risk perception literature, [60] studies in the context of flooding [18] and hurricanes [29, 30, 61] suggest that being female, and identifying as a racial minority predicted elevated hurricane risk perception. In contrast, the older, more educated individuals in these studies, along with those reporting higher household incomes, reported generally lower risk perception. [29,30] In contrast, studies in the context of flooding generally report a positive correlation between age and risk perception. [18] Finally, homeownership appears important to weather and natural hazard-related risk perception, since homeowners tend to incur more loss than would a tenant in the case of an adverse event (e.g., flooding). [18] Given the possible importance of these sociodemographic characteristics on risk judgment, we consider them as control variables in the analysis.

2.5. Context: Hurricane Sandy

On October 29, 2012, Hurricane Sandy made landfall in Brigantine, New Jersey on the U.S. East Coast, producing sustained winds of 75 mph, and a storm surge between three and nine feet above ground level, forcing high coastal water levels from Georgia to Maine. [62] Measuring nearly 1,000 miles in diameter, the storm caused damage to a wide swath of highly populated coastal areas. Wreaking particular havoc in the Tri-State area of Connecticut, New Jersey, and New York, the storm cut off electricity for 8.5 million people, impacted more than 650,000 coastal homes, damaged public transit systems, and subjected travelers across the nation to delays from flooded runways at La Guardia and Kennedy Airports. [1] All told, Sandy was responsible for over $50 billion in damages and claimed 147 lives, despite repeated warnings from officials regarding the magnitude of the impending threat. [1] In the aftermath of the storm, considerable state and federal-level attention centered on understanding attitudinal and behavioral responses to the storm; the present study, for

instance, was funded approximately one year post-Sandy through National Oceanic and Atmospheric Administration (NOAA), and Connecticut, New York, and New Jersey Sea Grant.

3. METHODS AND ANALYSIS

3.1. Data Collection

In July 2014, we conducted an online pilot study with participants from a national (U.S.) panel maintained by Qualtrics. After editing the survey instrument based on our results, we proceeded to recruit participants for the main study. Participants were selected from a panel of U.S. adults (aged 18 and older) maintained by GfK (formerly Knowledge Networks) to participate in a web-based survey. Those who agree to participate in the GfK panel complete a demographic questionnaire and then respond periodically to questionnaires via the Internet. To increase population representativeness, GfK provides Internet access to households without it. In particular, our sampling frame consisted of individuals who resided (at the time of the study) in New York, New Jersey, or Connecticut (Tri-State area) counties that experienced any type of storm surge or flooding associated with Hurricane Sandy. Counties were identified using publicly available GIS data gathered by the Federal Emergency Management Agency (FEMA), and included both coastal and inland counties. Between October 28, 2014 and March 2, 2015, a total of 619 responses were collected.[2]

3.2. Questionnaire Format

The questionnaire consisted of two main parts. Part one included questions broadly related to participants' experiences during Hurricane Sandy and general perceptions of hurricanes, including impacts they may have experienced, risk judgment, attitude toward hurricane-related information, and perceptions of responsibility of various social actors (see below and Table 1 for specific measures). Part two consisted of an experimental section in which participants were presented information about a hypothetical hurricane, including its intensity and predicted path, and asked a series of questions about their intended behavior (results not discussed in the present paper). A final section included

basic demographic measures and questions about other individual characteristics. Average completion time for the questionnaire was 35 minutes.

3.3. Measures

3.3.1. Risk Judgment

Risk judgment consisted of two sets of measures: (1) the perceived likelihood that "a storm like Sandy" will harm various groups ranging from "you and your family" to "the U.S. East Coast" (6-point scales ranging from (1) very unlikely to (6) extremely likely) ($\alpha = .87$), and (2) the perceived severity of the threat to these groups (6-point scales ranging from (1) not at all serious to (6) extremely serious) ($\alpha = .89$). [63] Product terms were created based on these two dimensions and averaged into an index to assess risk judgment (range 1- 36, $M = 15.18$, $SD = 7.31$).

3.3.2. Awareness of Sandy Forecast

Six items were developed to gauge participants' awareness of officials' (e.g., forecasters) predictions about the severity of Hurricane Sandy prior to the storm's making landfall (e.g., "our local decision makers made it very clear that the storm surge would severely impact our area"), and were measured on a 6-point scale from 1 (strongly disagree) to 6 (strongly agree). After reverse coding two items, items were averaged into an index ($\alpha = .75$, $M = 4.24$, $SD = 0.84$).

3.3.3. General Hurricane Experience

Three items measured the extent of participants' previous experience with hurricanes, taken from Trumbo et al. [30] (e.g., "how many hurricanes have you been in?"; "how many times have you evacuated from a hurricane?"), on a scale of 1-5, with 1 indicating none and 5 indicating 7 or more times/hurricanes. These items were summed to create an index of general hurricane experience (range 3 – 15; $M = 5.44$, $SD = 1.74$).

3.3.4. Hurricane Sandy Experience

Six items asked specifically about experience during Hurricane Sandy, including whether an evacuation order was in place at one's location, and whether the individual suffered any personal losses {yes, no, don't know/can't remember}. Don't know/can't remember responses were excluded from the analysis. The "yes" responses (coded as 1) were summed to create an index of Hurricane Sandy experience (range 0 – 6; M = 2.30, SD = 1.66). An additional variable measured whether the individual had evacuated during Hurricane Sandy (n = 43 or 7.4% of the sample reported evacuating).

3.3.5. Internal Attribution of Responsibility

Six items adapted from Ben-Porath and Shaker [47] and measured on a 6-point scale from (1) strongly disagree to (6) strongly agree gauged participants' perception of individuals' responsibility with respect to the storm and its aftermath (e.g., "people who did not heed the evacuation orders are responsible for what happened to them"), which were also averaged to create an index of internal responsibility (α = .76, M = 4.38, SD = 0.80).

3.3.6. Attitude toward Information

Following Kahlor, [64] we assessed participants' attitude toward hurricane information by asking them to indicate on a 6-point scale from 1 (strongly disagree) to 6 (strongly agree) the extent to which "understanding the risks posed by hurricanes" is seen as useful, beneficial, wise, and/or valuable (α = .97, M = 5.20, SD = 0.90).

3.3.7. Source Credibility

Following Trumbo and McComas, [16] we gauged participants' perceived credibility of information about hurricane evacuation from four mass media sources (e.g., The Weather Channel) using a series of three items with a 6-point semantic differential scale (i.e., can be trusted/cannot be trusted; is accurate/is inaccurate; tells the whole story/does not tell the whole story). After measuring credibility for each individual source (and determining appropriate reliability), we calculated a source

credibility index by averaging the credibility scores across all four sources (α = .87, *M* = 4.12, *SD* = 1.01).

3.3.8. Individual Characteristics

Demographic characteristics measured included age (*M* = 53.57, *SD* = 16.04), sex (56.9% female), and race/ethnicity (70.1% non-Hispanic White). In addition, we measured other individual characteristics often associated with natural hazard-related behavior, including: (a) length of time in current home (77.9% had lived in their current home for 5 years or more); (b) level of education (29.9% reported completing a Bachelor's degree); (c) relationship status (45.9% married); (d) homeownership (62.7%); (e) whether the participant had children (20.0% had at least one child under the age of 18 at home); (f) household income (55.4% reported $60,000 or above; and (g) primary language spoken at home (94.2% English).

[TABLE 1]

3.4. Analysis

Hypotheses and research questions 1 and 2 were tested using statistical path analysis in Mplus v7.3. To test the proposed relationships simultaneously, path analysis was used instead of structural equation modeling because of the limited sample size, which could not afford the ratio of the number of cases to the number of free parameters that is required for a full SEM (p. 111).[65] Descriptive and reliability statistics were computed for key variables and indices using SPSS. To examine the relationship between internal attribution of responsibility and risk judgment (RQ3), two models that specified the path between these two variables in the opposite directions were compared (Table 2).

4. RESULTS

The first hypothesis stated that awareness of Sandy forecast (H1a) and source credibility (H1b) would be positively related to participants' attitude toward hurricane information. Results from

the path analysis indicate support for H1. Participants who had a greater awareness of the Sandy forecast were more likely to have a favorable attitude toward relevant information ($\beta = .11$, $p < .05$). Similarly, participants who perceived greater credibility of the mass media sources named were also more likely to have a favorable attitude toward relevant information ($\beta = .16$, $p < .01$). Together, these two variables accounted for 5% of the variance in attitude toward information (Table 2; Figure 1).

[TABLE 2 and FIGURE 1]

The second hypothesis stated that participants with various types of experience, including general hurricane experience (H2a), specific Sandy experience (H2b), and having evacuated during Sandy (H2c), would be less likely to make internal attributions of responsibility. While participants with direct Sandy experience were less likely to make internal attributions ($\beta = -.15$, $p < .01$) (supporting H2b), general hurricane experience was not related to internal attribution (no support for H2a). In contrast to H2c, those who evacuated ($\beta = .11$, $p < .05$) were *more likely* to make internal attributions. Results from the path analysis also showed that female participants were less likely to make internal attributions ($\beta = -.10$, $p < .05$), whereas those who owned their home were more likely to make internal attributions ($\beta = .13$, $p < .05$). Further, as shown in Table 3, awareness of the Sandy forecast ($\beta = .03$, $p < .05$) and source credibility ($\beta = .04$, $p < .01$) also exerted significant indirect influence on internal attribution. Together, these variables accounted for 27% of the variance in internal attribution.

[TABLE 3]

The first research question explored the relationship between both general experience with hurricanes (RQ1a) and specific experience with Sandy (RQ1b) and risk judgment. Results from the path analysis showed that participants who had direct or indirect (e.g., knowing someone who was affected) experience with Sandy were more likely to report greater risk judgment ($\beta = .44$, $p < .001$), as were those who had general experience with hurricanes ($\beta = .11$, $p < .05$).

The second research question (RQ2) examined how attitude toward hurricane information relates to internal attribution of responsibility. According to the path analysis results, participants with more favorable attitudes toward hurricane information were more likely to attribute responsibility for Sandy impacts to individuals themselves ($\beta = .28$, $p < .001$).

Finally, the third research question explored the relationship between internal attribution and risk judgment (RQ3). With cross-sectional data, we cannot claim causality; however, results from two different model specifications suggest that internal attribution exerted a direct effect on risk judgment, and this relationship was unlikely to be in the opposite direction (Table 2). Model fit for the second model was significantly better than that for the first model, while all other specifications in the model remained the same. Thus, we can conclude that participants who made more internal attributions also reported greater risk judgment ($\beta = .13$, $p < .01$). Further, while awareness of Sandy forecast did not have a significant indirect effect on risk judgment, both source credibility ($\beta = .01$, $p < .05$) and attitude toward Sandy information ($\beta = .04$, $p < .01$) did. Together, these variables accounted for 15% of the variance in risk judgment.

5. DISCUSSION

By surveying residents of a targeted geographical area impacted by Hurricane Sandy, this study adapted concepts from seminal models in the risk communication and natural hazards literature – RISP and PADM, respectively – to examine how individuals' recollections (measured two years following the event), including attribution of responsibility for the storm's negative consequences, attitude toward hurricane information, and past experience with hurricanes, related to risk judgment for a future event. While some results confirm past findings in the risk perception and natural hazards literature, such as the positive relationship between experience and risk judgment, others suggest additional layers of complexity to the variables measured, namely, the mixed findings for the relationships between experience, risk perception, and attribution of responsibility. In the following sections, we first review the theoretical implications of our study for risk perception and behavioral

decision-making research (in the context of hurricanes, specifically, and natural hazards, more generally), present practical applications of our results, suggest study limitations, and end with opportunities for future research.

5.1. Theoretical Implications

Both confirming past research and raising new theoretical possibilities, results showcase the complex relationship between attribution of responsibility for an unwanted outcome, experience with a risk, and risk judgment. In the present study, participants expressing a favorable attitude toward hurricane information, in general, were more likely to make internal attributions, as were those who reported having evacuated during Hurricane Sandy, and those who owned their homes. When individuals view contextually relevant, preventive measures – such as obtaining information about a hurricane – as important, they may assume the same point-of-view of others around them, and thus perceive them as blameworthy for not exerting adequate effort to seek (arguably) necessary knowledge. Using this line of reasoning, those who chose to evacuate perhaps judged others as similarly able to leave their homes to ensure their (and close others') safety – and blameworthy given storm-related losses. Following the concept of "defensive attribution," [51, 52, 66] these internal attributions may follow from individuals' need to think of unfortunate events, such as experiencing loss during a hurricane, as avoidable given satisfactory effort on the part of the individual. Perceiving hurricane victims as culpable, thus, may serve a self-protective function: a way for individuals to convince themselves that disaster can be averted given appropriate preparation. Similar work explicating the so-called "just world hypothesis" [67] suggests that individuals may be drawn to derogate an innocent victim in order to preserve a systematic view of a fair world – one that punishes the guilty, for instance – as we navigate an increasingly complicated daily life. Further understanding the relationship between evacuation choice and attribution of responsibility will, however, require knowing more about the *nature* of the evacuation, [68] such as whether individuals were satisfied with their choice to leave, or experienced regret due to negative aspects of the experience.[3]

In contrast to those who evacuated, individuals who reported direct or indirect Sandy experience, operationalized in this study as experiencing losses related to the storm, for instance, were less likely to "blame the individual" for the negative consequences of the storm. In other words, "experienced" individuals were less likely to hold other individuals accountable for negative storm consequences – a result consistent with the concept of "blame avoidance." [56,66,69] That is, viewing themselves as (presumably) *similar* to others impacted by Sandy, they may have been motivated to attribute the unfortunate consequences of the storm to external factors, such as local or federal government incompetence, rather than to individual characteristics or decisions of the individual, such as ignoring evacuation orders. The impact of gender on attribution of responsibility is consistent with extant research, including a recent study showing females less likely than males to attribute internal responsibility to the victim of a hypothetical accident. [56]

Results also shed light on possible predictors of attitude toward hurricane information, while identifying a need for further investigation. Indeed, only 5% of the variance in attitude toward information was accounted for by the other information-related variables included in the analysis – source credibility and awareness of the Sandy forecast – suggesting that other, unmeasured variables most likely contribute to attitude toward available information. Future research should explore what these variables might include, including use of social media sites, such as Facebook and Twitter. Past research suggests that these platforms may be critical vehicles of information dissemination about a natural hazard event from "official" sources (e.g., The National Weather Service) and citizens alike, whether through providing up-to-date forecasts, sharing on-the-ground accounts, or delivering temporally- and geographically-specific information about post-storm resources. [70-72] Moreover, future work could capture more explicitly the perceived credibility of individuals involved in conveying local preventive and emergency response information, including weather broadcasters, who have been shown to influence science-related attitude formation among their viewership. [73-74]

Because the analysis is based on cross-sectional data, we cannot claim causality between attribution of responsibility and risk judgment; however, the seemingly directional relationship sheds some light on the possible theoretical connection between these two variables. In this study, when participants judged individual citizens responsible for the negative consequences of the storm, they were more likely to perceive greater hurricane-related risk not just to the self, but also to the community at large. A possible explanation may be that when people believe those who are capable of enacting preventive behavior (i.e., their fellow citizens) have *chosen* not to do so – or that these citizens have not contributed their fair share to safeguarding their personal property – they subsequently believe that all community members will face greater hurricane-related risk. To explore this explanation, future research should measure the extent to which individuals view both themselves *and* others in their community as able to enact prescribed behaviors to avoid hurricane-related risk. More fine-grained measures of risk judgment can be used to assess whether avoiding hurricane-related risk is perceived as under the control of an individual, or whether the impacts of a storm may be seen as product of fate, chance, or bad luck. [42,75] Beyond the context of hurricanes, a broader conceptualization of "protection responsibility" in models such as PADM to encompass not just an individual's perceived responsibility, but also "shared responsibility" (i.e., the idea that preparing for, or responding to, a given event comprises distinct, and/or inter-related responsibilities of multiple parties) might benefit our understanding of disaster and natural hazard attitudes and decision-making more generally. [7,39] Moreover, whereas much of the natural hazards literature refers to examples of time-bound, isolated hazard events, such as tornadoes, hurricanes, or earthquakes, future research might also examine whether the relationship between risk judgment and attribution of responsibility might persist for natural hazards more diffuse in time, scale, and locus of causality, such as sea level rise or ocean acidification.

5.2. Study Limitations

Before discussing the practical implications of this work, we first acknowledge possible limitations. We surveyed respondents about Hurricane Sandy because of the storm's significant impact on the Tri-State area and the event's corresponding salience among the area residents; given the fundamental role of memory of past hazards in perceived risk of future hazards, recollections about Sandy carry clear value for modeling judgments of future hurricane risk. However, because our survey was conducted approximately two years after Hurricane Sandy made landfall, it is possible that survey responses may reflect, in part, inaccuracies in recall that are likely to intrude as the time between a remembered event and the present grows larger. [76] For instance, hurricane risk judgment may change over time, such that individuals develop an increasing optimistic bias – i.e., the propensity to see others as more at risk than oneself [32]; lacking longitudinal measurement of study variables, we cannot determine whether this might have been the case among this study sample. Second, as mentioned above, the cross-sectional nature of the data limit inferences about causal relationships between key study variables. Third, as would be expected, a relatively small proportion (7.4%) of our sample reported evacuating during Hurricane Sandy; a larger proportion would have allowed us more confidence in the relationship between past evacuation, attribution of responsibility, and risk judgment. Finally, although the model only accounted for a moderate proportion of variance in risk judgment (15%), it was on a par with past research that also examined hurricane-related risk perceptions. [29, 30, 32, 77] Similar to these studies, despite the low R^2 in the endogenous variables, the statistically significant predicting variables identified in this research still provide meaningful information regarding the socio-psychological factors that constitute risk perception in this research context.

5.3. Practical Implications and Future Research

Compared to the effect of past hurricane experience, both attribution of responsibility and attitude toward information exert much smaller effects on risk judgment. While this result may be unsurprising on the basis of past research reviewed above, [31] when viewed in light of efforts by

federal agencies engaged in weather and natural hazard-related forecasting, at least two implications and directions for future research emerge. First, past evidence suggests that federal agencies like the National Weather Service (NWS) devote considerable attention to the role of mass media prior to, and during severe weather events like Sandy, such as understanding how citizens receive information about the storm, as well as the information content, perceived credibility, and consistency. [78-79] Further, in the meteorologically unique case of Sandy, agencies such as the National Hurricane Center (NHC) questioned whether the decision to label the storm as a "hurricane" versus a "tropical storm" in public communications may have affected subsequent decision-making among emergency managers and local residents. [1,80] While source credibility and message content are no doubt important contributors to hazard-related risk perceptions, results from the present study suggest that prior experience may exercise an even more central role. We suggest that future research explore methods to incorporate past weather- or natural hazard-related recalled experience – on the community level, for instance – into site-specific preventive messaging about a future storm. [68]

Second, since ascriptions of responsibility may influence risk judgment (as the present study shows), and, as other research shows, predict related behaviors, [75] further attention is needed to both *how* – and/or *when*—weather and natural hazard-related attributions are formed, and *who* makes them. Whereas the present study asked individuals to attribute responsibility retrospectively for the negative effects of Sandy (i.e., "people who did not heed the evacuation orders are responsible for what happened to them"), one might also ask people to project about future responsibility for avoiding such effects (i.e., "in the event of a storm like Sandy, government agencies should be responsible for informing citizens of possible impacts"). Further care might also be taken to compare attributions of responsibility to the individual versus to an "impersonal institution" [81] such as a government agency or television station. Future research should explore the relationship between retrospective and prospective attributions of responsibility, and, possibly, how hurricane-related attributions, like risk perceptions, may change over time [32] – such as prior to, during, and after a given event. Moreover,

the present study suggests that certain individual characteristics, such as being a homeowner or identifying as female, as well as experiential variables, such as whether one evacuated from a past storm, may precipitate attributions of responsibility and, in turn, amplify (or attenuate) risk judgment. These results underline the importance of targeting emergency preparedness messages, when possible, to increase the likelihood that a particular audience interprets – and, by extension, acts on – the message as intended.

NOTES

1. Since Sandy behaved in an atypical pattern hours before landfall in the U.S., the meteorological community referred to it as a "post-tropical cyclone," issuing associated watches and warnings. As a NOAA post-storm service assessment explains, "The storm evolved when a tropical cyclone merged with an intense low pressure system and dramatically increased in size before landfall" (NOAA, 2013, p. 1). For the sake of simplicity, we refer to the event as Hurricane Sandy throughout the manuscript.
2. A total N of 1036 panelists was contacted and 665 completed the survey, for a completion rate of 64.2%. Of those completing the main survey, 619 qualified for the main survey (i.e., an incidence rate of 93.1%). Information regarding the participation rate of Knowledge Panel is available at http://www.gfk.com/.
3. An additional survey question (not included in the present analysis) gauged participants' satisfaction with their "evacuation decision," and was measured on a 6-point scale from 1 (very dissatisfied) to 6 (very satisfied). On average, participants expressed a great deal of satisfaction with their decision (M = 5.15, SD = 1.15; 49.1% *very satisfied* with decision) that, for the majority of people surveyed, did *not* include evacuating. Further research is needed to assess instances where satisfaction may be less uniform.

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Table 1

Descriptive data for key variables (N = 619)

Concept	Measures	*M*	*SD*
Awareness of Sandy Forecast (1-6 scale; α = .75)	Meteorologists predicted that storm surge, the pushing of ocean waters onto land, would occur with Sandy.	4.59	1.09
	The media conveyed that the storm surge would be severe in our area.	4.13	1.32
	I did not hear that our area would experience such a high storm surge. **(REV)**	4.12	1.42
	Our local decision makers said that the storm surge would not be that bad. **(REV)**	4.27	1.24
	I trusted the weather broadcaster's storm surge forecast.	4.28	1.97
	Our local decision makers made it very clear that the storm surge would severely impact our area.	4.00	1.38
	Averaged scale	4.24	0.84
Source Credibility (1-6 scale; α = .86)	Your public access local TV channel	3.05	1.01
	Local media (ABC, NBC, CBS, FOX)	2.95	1.05
	National media (MSNBC, FOX News, CBS News)	2.83	1.04
	The Weather Channel	3.45	1.05
	Averaged scale	3.08	0.87
Attitude toward Information (1-6 scale; α = .97)	*Understanding the risks posed by hurricanes is:*		
	Wise	5.24	0.89
	Useful	5.24	0.88
	Valuable	5.19	0.91
	Beneficial	5.22	0.88
	Averaged sca	5.20	0.89
General Hurricane Experience (1-5 scale)[1]	How many hurricanes have you been in?	2.85	1.24
	How many times have you evacuated from a hurricane?	1.18	0.49
	How many times have you had property damage from a hurricane?	1.40	0.61
	Summed scale	5.44	1.74
Hurricane	Did you experience any personal loss from Hurricane Sandy?	0.23	0.42
	Did someone you know experience any personal loss from Hurricane Sandy?	0.69	0.46

Sandy Experience (0 = no;1 = yes)[2]	Did your home experience any storm surge from Hurricane Sandy?	0.16	0.36
	Did your neighborhood experience any storm surge from Hurricane Sandy?	0.37	0.48
	Did your community (e.g., town, city) experience any storm surge from Hurricane Sandy?	0.66	0.48
	Was there an evacuation order for your area during Hurricane Sandy?	0.18	0.38
	Summed scale	2.30	1.66
Individual Attribution of Responsibility (1-6 scale; α = .76)	People who did not heed the evacuation orders are responsible for what happened to them.	4.46	1.20
	Most people who remained in an evacuation zone after the evacuation orders did so because they could not leave on their own. **(REV)**	3.95	1.23
	The people who remained in an evacuation zone after the evacuation order acted irresponsibly.	4.45	1.30
	The people who remained in an evacuation zone after the evacuation order could have left the area if they tried hard enough.	4.13	1.26
	Most people who stayed in an evacuation zone chose to do so.	4.71	1.06
	People were responsible for seeking information about the risks posed to them and their property.	4.55	1.06
	Averaged scale	4.38	0.80
Risk Judgment (susceptibility * severity)	*Perceived susceptibility* (1-6 scale)*:* *In the event of a storm like Sandy, how likely is it that the following would be harmed:* You and your family	3.01	1.29
	Your home/apartment.	3.18	1.35
	Your local community.	3.94	1.35
	Your neighbor's home/apartment.	3.26	1.38
	The U.S. East Coast.	4.99	1.12
	Perceived severity (1-6 scale): In the event of a storm like Sandy, how serious would the threat be to the following?		
	You and your family	3.10	1.43
	Your home/apartment	3.10	1.42
	Your local community	3.89	1.40
	Your neighbor's home/apartment	3.21	1.45
	The U.S. East Coast	4.94	1.19

	Calculated scale	15.18	7.31

Note.[1] 1 = 0; 2 = 1-2; 3 = 3-4; 4 = 5-6; 5 = 7 or more.[2] Don't know/can't remember responses were excluded from analysis.

Table 2

Model fit indices (n = 410)

Model	χ^2	*df*	χ^2/df	RMSEA [90% C.I.]	*p-close*	SRMR	CFI	TLI
Risk -> Attribution	52.04	17	3.06	.071 [.049, .093]	.054	.028	.821	.525
Attribution -> Risk	29.26	17	1.72	.042 [.012, .067]	.670	.020	.937	.834

Table 3

Indirect effects of independent variables on the dependent variables

Variables	Internal Attribution	Risk Judgment
Awareness	.03*	.00
Source Credibility	.04**	.01*
Attitude toward Information	--	.04**

Note. * $p < .05$, ** $p < .01$

Figure 1

Standardized path coefficients for model with risk judgment as the consequence endogenous variable