The Effect of Proximity to Hurricanes Katrina and Rita on Subsequent Hurricane Outlook and Optimistic Bias

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This study evaluated how individuals living on the Gulf Coast perceived hurricane risk after Hurricanes Katrina and Rita. It was hypothesized that hurricane outlook and optimistic bias for hurricane risk would be associated positively with distance from the Katrina-Rita land-fall (more optimism at greater distance), controlling for historically based hurricane risk and county population density, demographics, individual hurricane experience, and dispositional optimism. Data were collected in January 2006 through a mail survey sent to 1,375 households in 41 counties on the coast ($n = 824$, 60% response). The analysis used hierarchal regression to test hypotheses. Hurricane history and population density had no effect on outlook; individuals who were male, older, and with higher household incomes were associated with lower risk perception; individual hurricane experience and personal impacts from Katrina and Rita predicted greater risk perception; greater dispositional optimism predicted more optimistic outlook; distance had a small effect but predicted less optimistic outlook at greater distance (model $R^2 = 0.21$). The model for optimistic bias had fewer effects: age and community tenure were significant; dispositional optimism had a positive effect on optimistic bias; distance variables were not significant (model $R^2 = 0.05$). The study shows that an existing measure of hurricane outlook has utility, hurricane outlook appears to be a unique concept from hurricane optimistic bias, and proximity has at most small effects. Future extension of this research will include improved conceptualization and measurement of hurricane risk perception and will bring to focus several concepts involving risk communication.

KEY WORDS: Hazard proximity; hurricanes; optimistic bias; risk perception

1. INTRODUCTION

This study evaluated how individuals living in U.S. Gulf Coast counties perceived hurricane risk in the wake of Hurricanes Katrina and Rita, which occurred in August and September 2005. The analysis examined optimistic bias for hurricane risk and perception of hurricane risk in January 2006, evaluating these concepts as functions of physical distance from the area of Katrina-Rita impact.

Surprisingly, little is scientifically known about the way in which individuals perceive risk from hurricanes or how they integrate such perception into life decisions such as where to live or whether to evacuate in the face of a threat. Improving understanding of the linkage between risk perception and decision making is of significant importance, especially as it has been observed in some disaster domains, flooding, for example, that individuals do not consider risk factors when selecting areas in which to live.[1–3] A clearer understanding of these associations will allow researchers to focus their work where greatest contributions might be made.

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Even less is known about how the proximity of an extreme event may subsequently influence hurricane risk perception. A better understanding of this question is of increasing importance given the continued growth of U.S. coastal populations,[4] the role of coastal development in the rising economic impacts of hurricanes,[5] and the possibility of stronger hurricanes in the future.[6] As coastal communities, states, and the federal government continually reassess their hurricane emergency planning, we hope that this line of research can inform the development and implementation of risk communications designed to best inform individuals about both impending and long-term hurricane risks.

2. BACKGROUND

2.1. Perception of Hurricane Risk

While a handful of studies have shown that hurricane risk perception is associated with storm preparation or evacuation behavior,[7−12] there is a remarkable lack of scientific understanding of how individuals in hurricane-prone areas perceive hurricane risk.

Flooding hazards, volcanoes, and earthquakes have received somewhat more scholarly attention, but are still comparatively unexamined relative to technological hazards.[13−16] And while the field of disaster research is devoted to a range of topics related to preparedness for, response to, recovery from, and mitigation of disasters,[17] it features very little attention to perception of risk. Leading researchers in the disaster community have noted the discrepancy between attention to natural versus technological hazards[18] and have called for attention to this disparity, with special emphasis on hurricanes.[19]

A study by Peacock *et al.* (2005) represents one of the few investigations of hurricane risk perception.[19] The researchers used a statewide phone survey to examine how single-family homeowners in Florida perceived hurricane risk. Using a three-item index for the dependent variable of hurricane risk perception ($\alpha = 0.73$), they looked at the influence of experiential (years as a Florida resident, hurricane experiences), sociodemographic (gender, age, income, race, education, children), and spatial (home location in wind hazard zones) factors. In a multiple regression analysis, they found all variables to be significant predictors of hurricane risk perception with the exception of the presence of children in the home, hurricane experience, and hurricane

knowledge. They call their measure "hurricane outlook," a term we will adopt from here forward.

2.2. Optimistic Bias

Researchers have enumerated a range of mechanisms that describe the way in which individuals tend to underestimate risk across a variety of domains. Such effects have been observed with respect to natural hazards, including, for example, earthquakes, wildfires, and floods.[1,20,21] Within that broader phenomenon there also resides the related effect of optimistic bias.[22,23] In general terms, optimistic bias (or comparative optimism) is the phenomenon in which individuals see themselves—in comparison to others—as less likely to be harmed by events in the future or as being more likely to achieve some goal or status.[23,24] Optimistic bias has been observed in a wide variety of contexts, including risk-taking behaviors (e.g., motorcycle riding, bungee jumping, smoking),[25−27] and vulnerability to health hazards (e.g., radon).[28]

In the context of natural hazards, optimistic bias has been examined with respect to earthquakes. Following the 1994 Northridge event, Helweg-Larsen[29] observed that individuals who experienced that earthquake displayed very little optimistic bias immediately following, as well as for several months after, the disaster. Individuals who experienced greater relative loss in the earthquake displayed the least optimistic bias.[29] A similar previous study by Burger and Palmer on the 1989 Loma Prieta earthquake found that optimistic bias was absent immediately following the earthquake but appeared at 3 months.[23] In a more recent study, Spittal *et al.* observed in a sample of New Zealanders (living in a seismic risk zone but not reacting to an event) that a strong optimistic bias was present for earthquakes.[35] Interestingly, this study showed that optimistic bias was positively associated with earthquake preparedness. Finally, Shepperd, Helweg-Larsen, and Ortega, in a study that included an additional analysis of the 1994 Helweg-Larsen earthquake data as well analysis of data involving other risks, observed that experience can have a temporary destabilizing effect but that individuals were generally consistent in their optimistic bias over time.[30] These aforementioned studies illustrate the likely importance of experience in moderating optimistic bias, the potential stability of optimistic bias over time, the relatively rapid reemergence of optimistic bias in the

aftermath of disaster, and the potential for optimistic bias to affect self-protective behavior.

Meta-analytic and review studies have recently provided useful overviews of other factors that may be associated with optimistic bias and may moderate its presence as well.[31,32] Two factors stand out as having clear relevance to natural hazards. First, a number of studies, conducted in a variety of contexts (including those above), find that past experience has a moderating effect on optimistic bias; specifically, having experienced the target negative outcome reduces the individual's tendency toward optimistic bias. Second, health research has shown that optimistic bias is associated with dispositional (trait) optimism.[33] Since dispositional optimism is a relatively stable trait, this concept may provide a benchmark against which a target-specific optimistic bias may be assessed.

While researchers have examined the persistence or return of optimistic bias following the personal experience of a natural disaster,[34] it is not known how two extreme events that for many were not experienced personally—such as Hurricanes Katrina and Rita—might affect the intensity or spatial distribution of optimistic bias or risk perception.[35] Anecdotally at least, it seems that individuals may consider recent but geographically distant extreme events in their calculus of risk, as described in news reports about Hurricanes Ophelia and Rita, at that time:

> Regardless of its strength, Ophelia merits respect, said Larry Jenkins, a worker at the Sportsman's Pier in Atlantic Beach. "With what's happened down there [on the Gulf Coast] and what's happened in Florida last year and this year . . . I think people are much more aware of the dangers and I don't think you'll see people taking it as lightly as they possibly would have otherwise," Jenkins said.[36]

> While [Florida] Keys residents typically pride themselves on refusing to budge for hurricanes, the recent images from Louisiana, Mississippi, and Alabama prompted many to leave [re: Rita].[37]

> Government officials, including county commissioners and Tampa's mayor, met Monday to talk about hurricane preparedness [re: Rita], an urgent topic pushed to the forefront by the devastation of Hurricane Katrina.[38]

After conducting an exhaustive literature search of several social science databases, we could find no literature on optimistic bias with respect to hurricanes. In the context of hurricanes, this may be associated with the way in which individuals understand the long-term risk associated with where they live (seasonal and multiseason hurricane risk perception). To a lesser degree, this may also influence the manner in which individuals interpret and react to storm-specific warnings.

2.3. Proximity Effects

The relationship between hazard proximity and risk perception is underexamined but not ignored. Researchers have studied social and psychological problems associated with living near environmental pollution.[39–42] Research has demonstrated, for example, that fear of cancer is more prevalent in communities located near toxic sites even when there is no greater incidence of serious illness in those communities.[43]

Recent work has used spatial analysis to understand the effect of hazard proximity on risk perception. Williams, Brown, Greenberg, and Kahn found that proximity to the Department of Energy's Savannah River Site was associated with greater risk perception, but the effect was moderated in individuals living in better economic circumstances.[44] Gawande and Jenkins-Smith examined approximately 9,000 real estate transaction records to find an association between proximity and perception of risk that negatively affected property values along nuclear waste transportation routes, also around the Savannah River Site.[45] Here again the association was moderated, with the association greatest in the more urban areas included in the study. In a study of Finnish citizens, Eranen found distance to be a strong predictor of heightened concern over radiation emitted from Russian nuclear power plants.[46] Moffatt, Hoeldke, and Pless-Mulloli examined risk perception, proximity of polluting industry, and socioeconomic status in eight European neighborhoods located in England and Germany. They found that proximity to polluting industry increased perception of risk in both countries.[47] They report that the association remained significant after controlling for unemployment and education. Read and Morgan examined how laypersons perceived risk from high voltage power lines. Individuals in their study reported heightened risk perception if the line could be seen, regardless of actual distance. This is counter to the rapid drop-off in radiation around such lines (following the inverse square).[48] And as discussed above, Peacock *et al.* observed that proximity to wind hazard areas was a predictor of a more optimistic hurricane outlook among Florida homeowners.[19]

No studies were found in which proximity to a natural disaster was examined for its influence on risk perception. However, Fischhoff, Gonzalez, Small, and Lerner did study the lasting effect on risk perception caused by proximity to an intentional act of terrorist violence. They found that judgments of terror risks, but not routine risks, remained elevated for certain individuals if they lived within 100 miles of the World Trade Center following the September 11, 2001, attacks.[49]

2.4. Hypotheses

Based on previous research examining hurricane risk perception, optimistic bias, and spatial risk perception, two parallel hypotheses will be advanced for the dependent variables. In the period shortly following Hurricanes Katrina and Rita, among individuals living in counties on the U.S. Gulf Coast:

H_{1-2}: Hurricane outlook (H_1) and optimistic bias for hurricane risk (H_2) will be associated positively with physical distance from the Katrina-Rita landfall area (more optimism at greater distance), controlling for location factors (historically based hurricane risk and county population density), demographics, individual hurricane experience, and dispositional optimism.

3. METHODS

3.1. Data Collection

Data collection was accomplished through a mail survey sent to households living in 41 counties immediately adjacent to the Gulf Coast. This sample area extends from Naples, Florida to Brownsville, Texas, with the exclusion of the area from the west side of Mobile Bay, Alabama to Galveston, Texas. The sample excluded the area of destruction from Hurricanes Katrina and Rita due to the ongoing disruption in this region. It is worth noting that Hurricane Ivan made landfall near the Florida-Alabama border the previous season. The Atlantic Coast was not included in the design for two reasons: the additional cost would have been prohibitive relative to the likely gain in findings and, second, the symmetry of the Gulf Coast provides a more unified meteorological and geographic domain in which to observe proximity. The sample area, based on counties, averaged 70 miles inland. This strip of land is home to approximately 7 million people, with an average of 300 persons per square mile.

The University of Wisconsin Survey Center was employed to execute the survey using best-response methods that included an advance phone call, a $5 incentive, and appropriate follow-up mailings. A stratified sample of 1,375 households was drawn by Survey Sampling International in which 41 coastal counties were first specified. Within each county between two and five zip codes were randomly selected, yielding a total of 141 zip codes.

Within each zip code, between eight and 20 households were randomly selected, the number depending on the number of zip codes per county (some counties had only two to four zip codes). The goal was to select at least 30 households per county. An average of 34 households were selected per county, with an average of 10 per zip code. The stratified sample design was employed in order to improve the spatial distribution of cases within counties. Simple random samples of county areas with embedded population centers tend not to be spatially random, but rather weighted toward the population centers. Instructions on the questionnaire indicated that any adult member of the household could complete the questionnaire.

Values reported in Peacock *et al.* were used for an *a priori* power analysis.[19] For regression, $n = 800$ was found to be sufficient to detect with 80% power an increment in R^2 of 1% over a base model including two measures of local conditions, up to five demographic variables, three hurricane experience variables, an index of optimism, and an index of hurricane outlook for the respondent's location (R^2 at minimum of 8%).

The survey was initiated on January 12, 2006 and returns were collected through March 17, 2006. A total of 843 questionnaires were returned. Using American Association for Public Opinion Research criteria, the response rate was calculated as completed returns divided by sample points minus nonsample cases.[50] Only seven nonsample cases were identified (deceased or noneligible adult respondent), yielding a response rate of 61.5%. Of the 843 completed returns, nine were subsequently eliminated because they had the tracking code removed (defeating geocoding) and 10 were eliminated because they fell outside of the defined study area (sampling errors). A final total of 824 cases were available for analysis (60% response).

3.2. Measurement

Two measures are included for use as dependent variables. First, a set of three questions taken from Peacock *et al.*[19] form a scale of hurricane outlook, each with a 5-point response running from "very unlikely" to "very likely" and recoded such that higher values represent greater optimism: How likely do you think it is that a hurricane will prevent you or members of your household from being able to go to work or go to your jobs during the next hurricane season? (*M* 2.9, *SD* 1.2); How likely do you think it is that a hurricane will disrupt your daily activities during the next hurricane season? (*M* 2.5, *SD* 1.1); and How likely do you think it is that a major hurricane will potentially damage your home during the next hurricane season? (*M* 3.0, *SD* 1.0). Missing values on the first (*n* = 11) and second (*n* = 5) items were replaced by series means. The three items form an additive scale with good reliability (α = 0.82, *M* 8.4, *SD* 2.9).

A second dependent variable was created for optimistic bias, following indirect measurement methods commonly used for this concept.[51] At separate places in the questionnaire, two items asked for the respondent's estimation of the probability of forced evacuation for others and self in the following hurricane season, with a response scale of 0–100% in 5% increments (then reverse coded such that high values indicate more optimistic outlook). Forced evacuation could be the consequence of an emergency order or a personal safety decision to leave. In either case it would reference a significant event. Missing values on both items (others *n* = 21, self *n* = 3) were replaced with the mode of 50. The items were: For the average individual living on the Gulf Coast, what would you say the chances are (from 0 to 100%) that he or she will be forced to evacuate from a major hurricane during the next hurricane season? (*M* 48, *SD* 27); and What would you say the chances are (from 0 to 100%) that you will be forced to evacuate from a major hurricane during the next hurricane season? (*M* 53, *SD* 29).

To compute optimistic bias, a difference score was calculated by subtracting the score for the average person from the individual's score, with positive values therefore indicating an optimistic bias (*M* 4.7, *SD* 24.2). A great deal has been written about the use of difference scores, with this debate largely unsettled.[52] For purposes here we can discount the common concern over multicollinearity among independent variables in linear regression. We can also largely disregard the issue of correlation between the difference score and the base or time-1 outcome in a repeated measure experimental design. Nonetheless, the most commonly suggested approach is to at minimum calculate the score as residuals. For the present study this approach was employed and compared to the simple difference score described above. No substantive differences were seen in the results to follow. The simple difference score was therefore used.

It should be noted here that the index of hurricane outlook and the difference measure of hurricane optimistic bias are not parallel in their underlying form. The former addresses three specific negative outcomes from a hurricane and the latter is a more global assessment of hurricane impact with respect to forced evacuation. There were two reasons for this discrepancy. First, the study was undertaken through a rapid support mechanism immediately after Hurricanes Katrina and Rita, which motivated a very brief questionnaire. An expanded set of optimistic bias items to match the hurricane outlook measure was not tenable for the single-page questionnaire. Second, our long-term interests in this work involve further development of a hurricane risk perception measure to supersede or augment the three-item assessment provided by Peacock *et al*. The evacuation-focused bias measure was anticipated to be more appropriate for the evacuation behavior studies we intended to later develop, and that are in progress. Needless to say this makes it impossible to directly compare to the measures. However, the analysis presented below is not designed to assess the two measures directly against one another, but rather evaluate each on its own merits with respect to the set of independent variables. Since the two measures are from the same conceptual and contextual domain, it nonetheless makes sense to present their results in combined form here.

A measure of dispositional optimism is included as a control covariate. The established Life Orientation Test—Revised was used.[53] This is a set of six items capturing complementary aspects of optimism (affirmation of optimism and disaffirmation of pessimism) along with another four filler items. The measure is scored 1–5 from "agree a lot" to "disagree a lot" and recoded such that higher values indicate greater optimism. The scale items are: In uncertain times, I usually expect the best. (*M* 3.8, *SD* 1.1); If something can go wrong for me, it will. (*M* 3.6, *SD* 1.3); I'm always optimistic about my future. (*M* 3.9, *SD* 1.0); I hardly ever expect things to go my way.

(*M* 3.8, *SD* 1.2); I rarely count on good things happening to me. (*M* 3.8, *SD* 1.3); and Overall, I expect more good things to happen to me than bad. (*M* 4.2, *SD* 1.1). There were a total of 32 missing values across the six items that were replaced by series means. The resulting additive scale ranges from 8 to 30 and has good reliability ($\alpha = 0.72$, *M* 23.0, *SD* 4.7).

Two measures of hurricane experience were also included. The first was a set of three items to indicate overall experience with three degrees of hurricane impact: How many hurricanes have you been in? (*M* 4.3, *SD* 3.2); How many times have you evacuated from a hurricane? (*M* 1.5, *SD* 1.9); and How many times have you had property damage from a hurricane? (*M* 1.3, *SD* 1.7). Missing values (62, 6, and 10 cases, respectively) were replaced by modal values of 1 and response ranges were truncated at 10. The resulting additive index has a reliability of $\alpha = 0.51$ and a strong negative skew (range 0–30, *M* 7.2, *SD* 5.0). To move the distribution toward normal, a square root transformation was applied (range 0–5.5, *M* 2.5, *SD* 1.0).

Second, a measure of experience with Hurricanes Katrina and Rita was included. Two items were used for each hurricane, for personal experience and associational experience, with yes/no responses (a total of seven missing values across the four items were coded with the modal response of yes): Did you experience any personal loss from Hurricane Katrina? (*M* 0.09, *SD* 0.29); Did someone you know experience any personal loss from Katrina? (*M* 0.36, *SD* 0.48); Did you experience any personal loss from Hurricane Rita? (*M* 0.08, *SD* 0.28); and Did someone you know experience any personal loss from Rita? (*M* 0.28, *SD* 0.45). The additive scale of the four items has a reliability of $\alpha = 0.61$ (range 0–4, *M* 0.82, *SD* 1.0).

The reliability for both hurricane experience measures is weak. In the first measure it may be the case that the three hurricane experience items are not strongly associated by virtue of the nature of hurricanes: evacuation experience is fairly uncommon, the majority of hurricanes are not major, and damage is much more likely in major storms. The negative skew of the distribution suggests that an overall lack of experience with landfalling hurricanes contributes to the poor reliability. In the second case, the two sets of measures (for Rita and Katrina) are independent since an individual might have been impacted by one but not both. However, as two item measures neither pair constitute an effective index. The measure was therefore a compromise, but nonetheless presents some information about the degree to which respondents had vicarious experience with those hurricanes.

The survey also included a set of demographic items used to measure gender, age, race/ethnicity, household income, education, household size, home ownership, and residence tenure. Means and modes were used to estimate missing values for sex (11 cases), age (41 cases), income (42 cases), education (5 cases), and years living in area (21 cases).

The final sample is 54% male with a mean age of 59 years (*SD* 15.4), and is 95% white and 12% Hispanic. Because of the lack of variance in the race and ethnicity measures, these are not included in the analyses (the spatial sampling strategy made other elements of representative sampling unfeasible within the constraints of the project). Household income was measured on a nine-point scale with the lowest bin less than $10,000 and the highest bin greater than $80,000. The mode for income was the fifth bin, $40,000 to $49,000 (*M* 5.1, *SD* 2.5). Education was measured on a seven-point scale with the lowest bin less than high school and the highest bin a Ph.D., M.D., or law degree. The mode for education was the third bin, some college or technical school (*M* 3.4, *SD* 1.6). The average number of children (under age 18) living in the household was 0.5 (range 0 to 4, truncated, *SD* 0.93), 67% of the respondents owned their residence rather than renting, and the respondents had lived within 50 miles of their current residence for an average of 24 years (*SD* 19).

Finally, a set of geographic variables was included. Population density for the county (persons per square mile) was added from the 2000 U.S. Census (range 8–3292, *M* 310, *SD* 556). The historical risk for hurricane landfall was calculated at the county level using data from the National Hurricane Center.[54] This was computed as the number of landfalling hurricanes during the years 1851–2004, weighted by the Saffir-Simpson Hurricane Intensity Scale and summed (range 24–79, *M* 54, *SD* 20). The resulting measure had six values and was far from equal interval so it was recoded 1–6 (*M* 4, *SD* 1.8).

A commercial service was employed to geocode respondents' street addresses into latitude and longitude coordinates.[55] Using the software package ArcGIS 9.0, geographic coordinates were used to calculate Euclidian distances in kilometers between respondents and the landfall location for Katrina (Buras-Triumph, Louisiana, approximately 70 miles southeast from New Orleans). To investigate the

possibility of a nonlinear distance effect, kilometers squared were also calculated.

4. RESULTS

This analysis used hierarchal ordinary least squares (OLS) regression to test our hypotheses. Table I shows the zero-order correlations among the dependent and independent variables. The means and standard deviations for each variable are listed along the diagonal of Table I. With hierarchal OLS we entered the independent variables in a series of groups, and the results represent the relative influence of each block on either hurricane outlook or optimistic bias while controlling for the other variables. Therefore, for each model we entered the two location-specific variables in the first block, individual characteristics in the second, hurricane experience and Katrina-Rita impact measures in the third, dispositional optimism in the fourth, and distance represented as a quadratic relationship in the fifth block. Table II shows these results from the full models for both dependent variables.

Beginning with hurricane outlook, recall that higher values indicate more optimism or belief that one is less likely to be affected by a future hurricane. Table II shows that the community's hurricane history and population density had little effect on individual hurricane outlook. Individual characteristics added in block 2 do affect hurricane outlook with men, older individuals, and those with higher household incomes predicted to be more optimistic about their hurricane risk. As expected, individual hurricane experience and personal impacts from Katrina and Rita negatively affected hurricane risk perception, indicating those who have experienced, been evacuated from, or had property damage from previous hurricanes and those with loss specifically from Katrina and/or Rita are more likely to believe they will experience future impacts from hurricanes even after controlling for other variables in the model.

In block 4, we controlled for general dispositional optimism, which, as expected, positively affected hurricane outlook controlling for the other variables. In the last block, we note that distance from New Orleans had a small but expectedly positive effect on hurricane risk perception. The effect of distance declined more rapidly at farther distances from New Orleans as shown through the significant effect of the quadratic term. The turning point for the effect of distance is 651 km, indicating that as Euclidean distance from New Orleans

Table I. Zero-Order Correlations, Means, and (Standard Deviations) on the Diagonal ($n = 824$)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
Hurricane Outlook (1)	8.4 (3.0)														
Optimistic Bias (2)	−0.02	4.7 (24)													
Hurricane History (3)	−0.00	−0.01	4.1 (1.8)												
Population Density (4)	0.06	−0.02	0.03	310 (556)											
Sex (5)[a]	0.11**	−0.00	0.06	0.02	0.54 (0.49)										
Age (6)	0.25**	−0.11**	0.08*	0.08*	0.04	58 (15)									
Household Income (7)	0.11**	0.11**	0.01	0.05	0.15**	−0.20**	5.2 (2.5)								
Education (8)	0.05	0.06	0.05	0.06	0.05	−0.10**	0.42**	3.4 (1.6)							
Children (9)	−0.13**	0.01	−0.10**	−0.04	−0.02	−0.50**	0.09*	0.01	0.49 (0.93)						
Home Ownership (10)[a]	0.06	0.06	−0.11**	−0.05	0.11**	−0.03	0.33**	0.17**	0.05	0.67 (0.47)					
Community Tenure (11)	−0.05	0.08*	−0.21**	−0.08**	−0.02	0.17**	−0.06	−0.16**	−0.07	0.12**	25 (19)				
Hurricane Experience (12)	−0.25**	0.01	0.01	−0.10**	0.01	−0.10**	0.01	0.02	0.07	0.05	0.22**	7.2 (5.0)			
Katrina-Rita Impact (13)	−0.27**	0.08*	−0.14**	−0.04	0.02	−0.12**	0.10**	0.09*	0.09*	0.03	0.06	0.28**	0.8 (1.0)		
Dispositional Optimism (14)	0.11**	0.12**	0.01	−0.02	−0.02	−0.03	0.27**	0.19**	−0.03	0.12**	0.02	0.05	0.08*	23 (4.7)	
Km from New Orleans (15)	0.24**	−0.07	−0.08*	0.16**	0.04	0.20**	−0.07*	−0.02	−0.11**	−0.12**	−0.15**	−0.38**	−0.32**	−0.10**	640 (201)

[a]Reporting *eta* for nominal by interval, *phi* for nominal by nominal.
*$p < 0.05$.
**$p < 0.01$.

Table II. Hierarchical Regression Models ($n = 824$)

	Hurricane Outlook					Optimistic Bias				
	β	b	$t_{(823)}$	ΔR^2	ΔF	β	b	$t_{(823)}$	ΔR^2	ΔF
Hurricane History	−0.06	−0.09	−1.8			0.03	0.46	0.9		
Population Density	0.01	0.00	0.1	0.004	$F_{(2,821)}$ 1.7	−0.004	−0.00	−0.1	0.00	$F_{(2,821)}$ 0.2
Sex	0.08	0.47	2.6**			−0.01	−0.47	−0.3		
Age	0.26	0.05	6.7**			−0.13	−0.21	−3.1**		
Household Income	0.13	0.15	3.5**			0.05	0.50	1.2		
Education	0.02	0.03	0.5			0.02	0.34	0.6		
Children	0.02	0.07	0.6			−0.05	−1.4	−1.3		
Home Ownership	0.03	0.15	0.7	0.11	$F_{(7,814)}$ 13.6**	0.02	0.88	0.5	0.03	$F_{(7,814)}$ 4.0**
Community Tenure	−0.05	−0.01	−1.4			0.12	0.15	3.0**		
Hurricane Experience	−0.13	−0.08	−3.8**	0.08	$F_{(2,812)}$ 41.9**	−0.06	−0.28	−1.5	0.01	$F_{(2,812)}$ 2.4
Katrina-Rita Impact	−0.20	−0.54	−5.7**			0.07	1.5	1.7		
Dispositional Optimism	0.11	0.07	3.3**	0.01	$F_{(1,811)}$ 9.7**	0.09	0.44	2.4*	0.01	$F_{(1,811)}$ 5.7*
Distance Km	0.54	0.01	2.7**	0.005	$F_{(2,809)}$ 5.5*	−0.02	−0.01	−0.1	0.00	$F_{(2,809)}$ 0.1
Distance Km²	−0.46	0.00	−2.3*	0.005	5.4*	0.01	0.00	0.1	0.00	0.00
Full Model				adj R^2 0.21	$F_{(14,809)}$ 15.6**				adj R^2 0.05	$F_{(14,809)}$ 2.7**

*$p < 0.05$.
**$p < 0.01$. Coefficients from full model.

increases, individuals' hurricane outlook becomes more optimistic until reaching a peak at 651 km from New Orleans and then leveling back. This result supports our hypothesis that physical distance from the Katrina-Rita landfall is positively associated with more optimism in hurricane risk after controlling for other variables in the model—although the effect is very small.

Moving to optimistic bias, again recall that higher values indicate more optimism or that the individual estimates he or she is less likely to experience forced evacuation than the average Gulf Coast resident during the next hurricane season. Similar to hurricane outlook, the community-level predictors of population density and hurricane history had little effect on optimistic bias. Individual characteristics affected optimistic bias less than they affected hurricane outlook. In this model, only age and community tenure are statistically significant. This indicates older individuals were less optimistic (an opposite effect than in the previous model) and individuals who have lived longer in their current area had more optimistic bias. Next, neither personal hurricane experience nor experience with Katrina or Rita had a significant effect on optimistic bias. Dispositional optimism, as expected, had a positive effect on optimistic bias. Finally, our distance variables were not significant. This result does not support our hypothesis that distance will be positively associated with optimistic bias after controlling for other variables in the model.

5. DISCUSSION

Drawing on a randomly selected stratified sample of 824 individuals living along the U.S. Gulf Coast, this study tested two related hypotheses: that hurricane outlook (H_1) and optimistic bias for hurricane risk (H_2) will be associated positively with physical distance from the Katrina-Rita landfall area, controlling for location factors, demographics, hurricane experience, and dispositional optimism. While the first hypothesis was supported by the results of the hierarchical OLS, the second hypothesis was not. It should be noted here, as previously discussed, that these two dependent variables are not parallel in their underlying form and therefore cannot be directly compared. Rather, the analysis presented herein examines each measure independently.

This study shows that a three-item measure of "hurricane outlook" has potential to shed light on the factors that motivate individuals to orient toward

hurricane risk. Perceiving less hurricane risk is associated with general dispositional optimism and being male, being older, and having a higher household income. These results are consistent with results from the broader literature on risk perception.[56–59]

Having less past experience with hurricanes and less direct or associated experience with Katrina-Rita were also associated with less perception of hurricane risk. These findings suggest that the growing coastal population of individuals who have little or no hurricane experience may result in more individuals underestimating the risk involved with living in a hazard-prone area. The independent effect of distance from an extreme event—in this case, Katrina-Rita—although weak, indicates that physical proximity can play a role in shaping perception of risk. Specifically, the farther individuals lived from the Katrina landfall, the lower their perceptions of hurricane risk. This finding, although in the expected direction, is somewhat startling given the enormous destruction caused by Hurricanes Katrina and Rita. These storms, when taken together, were by far the most costly and deadly natural disasters in recent U.S. experience.[60] Yet, rather than encouraging consistent levels of risk perception along the Gulf Coast, physical distance from the Katrina landfall translated into more optimistic hurricane outlook among individuals.

The measure of optimistic bias yielded fewer significant relationships. Perhaps most interesting is that optimistic bias and hurricane outlook are not correlated with each other, but they are both correlated with the trait characteristic of dispositional optimism. This provides some support for the argument that both are valid measures, but are distinct in the context of hurricanes. While optimistic bias has been shown to be an important factor shaping behavior in a range of health- and safety-related contexts, it may not be as important a factor as risk perception with respect to hurricanes. Their differential basis in measurement makes these conclusions tentative, however. Further research is necessary to understand the seemingly complex relationship between optimistic bias and hurricane risk perception.

The findings with respect to optimistic bias may be due to two primary circumstances. First, the aspect of the measure that involves assessment of the risk faced by others is strongly conditioned on the definition of "others." In this particular survey, respondents were asked to assess the risk faced by an "average resident" of the Gulf Coast. It is likely well known by many if not most residents of the Gulf

that hurricane risk is not equal all across the coast. This component of the assessment may have in effect washed out any underlying bias that might have been best captured by indexing against others in the respondent's immediate area. Another possibility is that the phenomenon of optimistic bias simply does not operate in this context. Given the strength of the findings on optimistic bias across other contexts, this might be an important finding. That possibility, and the possibility that optimistic bias may not be applicable in the contexts of other natural hazards, provides merit for further examination of this concept.

It is important to note that optimistic bias and risk perception should be seen in light of whether they are objectively appropriate. In this case the equations are controlled by a measure of actual hurricane activity, allowing the possibility that reported perceptions are to some degree informed by actual risk factors. It is also worth noting that households located in counties with greater levels of historical hurricane activity tend to be younger, have fewer children, less home ownership, and shorter community tenure. These associations may suggest a tendency against households settling (and concomitant community development) in areas that are most hurricane prone although it must also be noted that there are certainly a good number of unobserved but relevant demographic and geographic factors that could influence these associations.

The concept of hazard proximity has a mixed presence in the research literature, as reviewed above. It should be pointed out that the very concept of proximity, as used here, could suffer from considerable reductionism. People do not orient toward an experience in which Euclidian distance is necessarily meaningful. Rather, individuals interact with a world consisting of terrain, roads, political boundaries, and such. Another complication is that some of the other variables involved in this study may also have a relationship with spatial location, and therefore the measure of distance (SES variables are often located together). This study does not reduce the ambiguity of the concept. Nonetheless, the fairly weak and mixed results do argue for continued research on this concept that does have importance on an intuitive level in this context and a well-developed track record in other contexts involving health and safety.

The findings of this study that most strongly argue for further investigation are those involving a measure of risk perception. Dash and Gladwin point out that risk perception plays a central role in the context of hurricane evacuation decision making.[61]

They describe how various hurricane researchers conceptualize risk in terms of probability and severity, or in terms of social meaning. A good deal might be brought to the development of a measure of hurricane risk perception by evoking a dual-process model in which both cognitive and affective elements are considered in concert.

In addition to informing the broader risk perception literature, as just discussed, several of our findings in this work also reinforce studies in the more specific area of natural hazards. We observe that a lack of hurricane experience may very well have the effect of lowering the perception of risk, as has been shown in studies on flooding, for example.[1–3] And flooding is a very significant component of hurricane risk. Further attention to this finding is merited and various avenues of exploration are presented in the literature. Of particular interest might be a consideration of how hurricane experience influences the way in which individuals imagine the affective impact of a disaster experience, which has been shown in work on flooding.[62] Given the importance of affect in risk perception, this may be a very useful intersection of concepts.

Our work on physical proximity offers new findings to an area of hazards research that may merit development. A recent study by Mishra and Mishra has shown, for earthquakes, that the presence of a state border attenuates risk perception.[21] Given the geographic spread of hurricane impact this effect may well be worth examination. Also, our findings on optimistic bias are fairly consistent with previous work where optimistic bias was not seen to have an effect in the context of earthquakes. Of considerable interest in the continuation of this research would be observing decreases in optimistic bias as a consequence of disaster experience, an effect that was reported by Weinstein in a study of communities having experienced tornadoes.[34]

There are limitations to our study. Pre-Katrina-Rita data on risk perception and optimistic bias among the sample population are unavailable, so it is impossible to compare pre- and postevent data. The study sample was less racially and ethnically diverse than the coastal population as a whole, and the lack of variance in the race and ethnicity measures did not allow for further analysis. The 60% mail survey response rate is considered "good" in the research methods literature;[63] however, a higher response rate would have yielded a more diverse cross-section of the targeted coastal population in terms of race-ethnicity, age, and family size.

Despite these limitations, this research advances understanding with respect to hurricane risk perception and, to a lesser extent, optimistic bias. Researchers have pointed out that inconsistent findings involving hurricane risk perception may be related to the lack of conceptualization and measurement consistency associated with this concept.[64,65] Other authors recently discussing the social science research agenda on hurricanes have also highlighted the need for improved conceptualization and measurement of hurricane risk perception.[66] In addition, the need to examine the temporal stability of hurricane risk perception has been described by these authors.[66]

There is also a need for attention to the differential characteristics of these factors across various natural hazards. A good share of the earliest and still very influential work on risk perception was based in the comparison of risk perceptions across various domains of technological hazard. Just as the objective and perceived risks of nuclear power differ from air travel, so may there be important differences (and similarities) between flash floods and tornadoes, for example. The literature attending to risk perception for natural hazards is growing and there may be, or soon be, sufficient findings to support at least a significant integrative review, or perhaps meta-analysis. Future studies using consistent designs across multiple natural hazards may also be undertaken. Such work has the potential to not only inform the hazards research community, but also the broader literature on risk.

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