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How Information Factors and Attitudes Relate to Symptoms of Post-Traumatic Stress Disorder: The Role of Uncertainty in the Case of Deepwater Horizon Oil Spill

ZHIWEN XIAO
JAESUB LEE
University of Houston, USA

The Deepwater Horizon oil spill, the largest in U.S. history, has impacted communities and residents, near and far, in numerous ways. This study proposed and tested a conceptual framework to examine the extent to which (a) information factors (sufficiency, repertoires, similarity, and sensitivity) and attitudes (feeling efficacious in seeking information and willingness/motivation to accept information) are associated with uncertainties in communities *during* the oil spill and (b) uncertainties, in turn, lead to symptoms of post-traumatic stress disorder (PTSD) *after* the spill. A cross-sectional survey study (N = 240) was conducted in the Houston Ship Channel area. Structural equation modeling was used to test the hypothesized conceptual model. Information sufficiency, information similarity, willingness to accept information, and efficacy in information seeking were significant predictors of uncertainty. These predictors explained 30.4% variances of uncertainty. Uncertainty was, in turn, a significant predictor of symptoms of PTSD. Current findings signify the importance of information factors and residents' attitudes in reducing uncertainty and symptoms of PTSD developed during crisis situations, including the current COVID-19 pandemic.

Keywords: crisis, oil spill, uncertainty, post-traumatic stress disorder, information seeking

The Deepwater Horizon oil spill (the Spill, from here on), which began on April 20, 2010, is the largest oil spill disaster ever in the history of the United States. The explosion of the drilling rig caused the deaths of 11 workers, serious injuries of 17 people, and an oil spill of 4.9 million barrels into the Gulf of Mexico for a period of 87 days (Robertson & Krauss, 2010).

Disasters of this magnitude certainly evoke "a sense of threat, urgency, and destruction, often on a monumental scale" (Seeger, Sellnow, & Ulmer, 2003, p. 4). Besides environmental devastation, such disasters cause numerous environmental, cultural, legal, cognitive, behavioral, and/or health uncertainties among involved communities and individuals (Koerner & Morales-Cruz, 2021; Nathan, Heath, & Douglas, 1992; Osofsky, Osofsky, Wells, & Weems, 2014). This sort of exposure to uncertainties, in turn, leads to

Zhiwen Xiao: zxia2@cougarnet.uh.edu
Jaesub Lee: jlee@central.uh.edu
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negative psychological effects. For example, the experience of uncertainty contributes to generalized anxiety disorder (Freeston, Tiplady, Mawn, Bottesi, & Thwaites, 2020), social anxiety disorder, obsessive-compulsive disorder, and panic disorder (Carleton, 2012; Hunt, Exline, Fletcher, & Teng, 2022). In addition, lower tolerance of uncertainty is associated with greater/increased post-traumatic stress symptoms (PTSS) and post-traumatic stress disorder (PTSD; Jung et al., 2022; Paltell, Zakeri, Gorka, & Berenz, 2022).

A substantial body of research on symptoms of PTSD documented that the risk of PTSD varies with its interactions with a group of protective and risk factors, including pre-trauma or preexisting factors (e.g., previous exposure to trauma, age, gender, ethnicity, and coping styles), trauma-related factors (e.g., type of event, severity, physical, and emotional proximity to the traumatic event), and post-trauma factors (e.g., social support; Abolhadi, Divsalar, Mosleh-Shirazi, & Dehesh, 2022; Dekovic, Koning, Stams, & Buist, 2008). These studies, however, have sidestepped a key issue in risk and crisis contexts: Communication in the event of disasters. Communication with the public, especially in disaster situations, is critically important to mitigate the public's fears and negative experiences of uncertainty, which, in turn, affects their participation in decision making, perceptions and behaviors, and sense of well-being (Lee, Benedict, Ge, Murray-Tuite, & Ukkusuri, 2020). As Brashers (2001) stated, "Uncertainty exists when details of situations are ambiguous, complex, unpredictable, or probabilistic; when information is unavailable or inconsistent; and when people feel insecure about their own state of knowledge or the state of knowledge in general" (p. 478). According to the information-processing theory (Miller, 1956) and the uncertainty-reduction theory (Berger, 1986), information about people, events, or objects would reduce an individual's uncertainty about these entities; when people experience uncertainty, they seek more information to reduce the uncertainty.

Limited research has examined the extent to which information factors and individuals' personal characteristics help reduce uncertainty during crises. Heath, Lee, and Ni (2009) have indicated that information sufficiency, information repertoires, information similarity, information sensitivity, willingness/motivation of people to accept information, and efficacy in information seeking facilitate messages to be absorbed into a community during crisis situations. However, they did not examine how these features and characteristics helped reduce uncertainty. A few studies investigated how some of these features are associated with uncertainty but obtained unexpected findings. For example, Lee and colleagues (2020) collected survey data among the households affected by Hurricane Matthew in 2016 in Jacksonville, Florida, and investigated how the perceived amount and consistency of information from multiple sources predicted uncertainty about the hurricane. They that found perceived consistency, rather than the perceived amount, significantly explained uncertainty. The lack of consistent findings in this line of research leaves a gap in understanding the management of uncertainty in disaster events, which can be addressed only by more specific research in this area.

Thus, the current study proposes a conceptual framework (see Figure 1) to examine (a) how these information features and personal characteristics are associated with the uncertainties developed in communities during the Spill in 2010 and (b) how these uncertainties are associated with possible symptoms of PTSD developed after the Spill. Figure 1 presents that information sufficiency, information repertoires, information similarity, information sensitivity, willingness/motivation of people to accept information, and efficacy in information seeking are associated with uncertainty, which is, in turn, associated with symptoms of PTSD. The following sections will review each of the concepts in Figure 1.

Information Sufficiency

Researchers have proposed the concept of information sufficiency as an important component for consideration in uncertainty-reduction management in disaster events. Information sufficiency is "an individual's assessment of the amount of information he or she needs to cope with risk" (Griffin, Neuwirth, Dunwoody, & Giese, 2004, p. 24) or "the point at which an individual is confident he or she has enough information to cope with an uncertain situation" (Sommerfeldt, 2015, p. 8). It is derived from the concept of the "sufficiency principle" or "sufficiency threshold" in the heuristic-systematic model (Chaiken, Liberman, & Eagly, 1989), which suggests that people in crises or at risk feel uncertain about these situations and sense that more information is needed and therefore seek information until they feel they understand the situation (Griffin et al., 2004). A sufficient amount of information is reported to be negatively linked with the levels of uncertainty people have about crisis situations (Sommerfeldt, 2015). Therefore, the following hypothesis is posited:

H1: When people felt they had more (or a sufficient amount of) information about the crisis of the Spill, they were likely to have experienced less uncertainty during the crisis of the Spill.

Information Repertoires

The uses and gratifications (U&G) theory posits that people are active and goal-oriented when they consume media to meet their particular needs or motivations for information (Ruggiero, 2000). However, most U&G studies have assumed that individuals use only one type of medium independent of other medium options to satisfy one particular gratification (Yuan, 2011). Nevertheless, other studies have argued that individuals would often use a variety of media to obtain information before, during, and after crises (Seeger et al., 2003) because they need to receive confirmatory or consistent information from multiple sources to reduce uncertainty (Lee et al., 2020; Sellnow & Seeger, 2013). Therefore, a number of studies have employed an "information repertoires" approach to investigate how individuals use media in combination to meet their particular needs (Lee et al., 2020; McClendon & Robinson, 2013). The term "repertoire" in this study refers to groupings of available media people use for information (Webster & Ksiazek, 2012).

Television and radio are still the primary channels through which people gather information about disasters (Lee et al., 2020; Spence, McIntyre, Lachlan, Savage, & Seeger, 2011). In addition, affected individuals often use other media (e.g., print media) and personal sources (e.g., friends and neighbors) to gain information about crises and disasters (Lee et al., 2020; Spence, Lachlan, Burke, & Seeger, 2007). For example, Spence, Lachlan, and Burke (2008) documented that individuals used face-to-face communication as a critical source to gain information following Hurricane Katrina. Recent studies have investigated the importance of information seeking through online media in disaster situations (e.g., Austin, Liu, & Jin, 2012; Lee et al., 2020). These studies suggest that online and social media are also very helpful in reducing uncertainties during a crisis. In addition, research found that individuals in disaster events would combine traditional and new media sources to satisfy their information needs (Lee et al., 2020; Yuan, 2011). Thus, the current study hypothesizes that

H2: Residents who received information about the Spill from greater repertoires (e.g., social media, news media, face-to-face communication with family and friends, city government, etc.) were likely to perceive fewer uncertainties about the Spill.

Information Similarity and Sensitivity

According to Burke's (1969) identification theory, to persuade audiences and provoke their action in crisis situations, information or communication must create a certain degree of identification among audiences, which is the feeling of relating to a person, an issue, or an organization. In other words, to have an impact on a receiver, any information or communication must be relevant to the receiver (O'Reilly, MacMillan, Mumuni, & Lancendorfer, 2016).

Information similarity and sensitivity are important persuasion tools to help audiences to develop such identification and relevance (Heath et al., 2009). Information similarity (or persona similarity) refers to the information receiver's assessment of how similar the information source is to him or her with respect to certain attributes (e.g., gender, education, race/ethnicity, and lived experience; Lu, 2013; O'Reilly et al., 2016). Hoffner and Buchanan (2005) have stated that audiences tend to feel similar to communicators or characters of narratives who are like themselves in terms of demographic characteristics. Information sensitivity refers to how a message is appropriate or sensitive to an audience's culture at "surface structure" or "deep structure" (Romer et al., 2009, p. 2150). Surface structure refers to the background, the use of language, and the use of channels of the audiences; and deep structure refers to the perceptions, beliefs, values, attitudes, and behaviors of the audiences in reducing or managing the risk (Romer et al., 2009). Surface structures are frequently used to increase audiences' acceptance of the messages, and deep structures are more likely to be employed to enhance the effectiveness of the messages (Huang & Garcia, 2020).

Information similarity and sensitivity positively influence source credibility and the level of persuasion of the information (Heath et al., 2009; Ooms, Hoeks, & Jansen, 2019), which, in turn,

> increase residents' sense of self, expert, and community preparedness. If citizens have access to information that is from sources similar to them and stated in messages that are sensitive to them, they feel more prepared to deal with crisis emergency response. (Heath et al., 2009, p. 123)

Eagly and Chaiken (1993) have also stated that when individuals feel the message is personally relevant, they would be motivated to process the message more systematically. When individuals feel they are prepared or the information is relevant to them, the uncertainty would be reduced (Burke, Perry, & Brown, 2010). In this study, similarity refers to matching the communicator or information source's demographics (such as race/ethnicity, age, gender, income, and education) to those of the audiences; and sensitivity refers to being sensitive to the "surface structure" of an information receiver's culture. The current study posits the following hypotheses:

H3: When the residents perceived that information sources were more similar to them demographically, they were more likely to experience less uncertainty.

H4: When the residents perceived greater message sensitivity, they were more likely to experience less uncertainty.

Willingness/Motivation to Accept Information

Even though the uncertainty-reduction theory (Berger, 1986) states that people seek more information to reduce uncertainty, research has found that individuals make different decisions about coping with anxiety and uncertainty (Chang, 2014). Some might want to avoid or be unwilling to gain information so that they can escape from the uncertainty (Brashers, Goldsmith, & Hsieh, 2002). Therefore, the willingness of people to receive emergency management communication or information is another important concern in crisis situations (Heath et al., 2009). Such concern exhibits whether the communication/information is persuasive and can generate an intense (e.g., panic) or passive (e.g., indifference) personal response among the receivers. Darke and colleagues (1998) found that persons who were more motivated to learn about a topic scrutinized a passage about the issue more thoroughly. van Lieshout, Traast, de Lange, and Cools (2021) also demonstrated that curiosity (or a motivational state) that stimulates information seeking is related to uncertainty reduction. The willingness of individuals to receive and process crisis-related information in a particular crisis influenced the type and amount of media and interpersonal communication (Kasperson, 1992) and helped reduce their uncertainties about the crisis. Accordingly, the following hypothesis is proposed:

H5: The more the residents were willing to accept information from various sources during the Spill, the less uncertainty they perceived about the Spill.

Efficacy in Information Seeking

Bandura (1997) stated that perceived self-efficacy "supports the type of efficient analytic thinking needed to ferret out predictive knowledge from causally ambiguous environments in which many factors combine to produce effects" (p. 35). Afifi and Afifi (2009) have specified that "communication efficacy," a person's belief in his or her own ability to understand and seek information, is critical to the person's information management decisions. In other words, communication efficacy plays an important role in predicting the information-seeking behavior of people who experience uncertainty, and if people feel they lack communication efficacy, they might avoid information seeking (Afifi & Weiner, 2004). Ju, Ohs, Park, and Hinsley (2022) found that although efficacy beliefs have generally been treated as a mediator in the relationship between uncertainty and information seeking, they can also exert moderating effects on the relationship. Based on the uncertainty reduction theory (Berger, 1986), the lack of information seeking would not help people reduce the uncertainty they experience, rather, it might increase their uncertainty. However, past studies have mainly focused on the relationship between perceived efficacy in information seeking and actual information-seeking behavior. This study instead aims to examine the direct relationship between self-efficacy in information seeking and uncertainty. Toward that end, the following hypothesis is posited:

H6: Greater perceived efficacy in information seeking was related to less uncertainty among the residents affected by the Spill.

Uncertainty and PTSD

PTSD refers to an intense, prolonged, and sometimes postponed response to traumatic events (Abolhadi et al., 2022). It has been frequently documented as negative psychological effects of disasters (Arata, Picou, Johnson, & McNally, 2000). Symptoms of PTSD include reexperiencing the trauma (e.g., recurrent thoughts or dreams of the disaster), avoidance or numbing symptoms (e.g., avoidance of disaster-related activities, feelings of detachment), and hyperarousal (e.g., difficulty in concentrating or sleeping; Abolhadi et al., 2022).

Research on the relationship between uncertainty and PTSD in traumatic events has focused on natural disasters (e.g., earthquakes) in which most negative psychological symptoms generally dissipate within two years (Fetzner, Horswill, Boelen, & Carleton, 2013). In contrast, "Oil spills are unlike natural disasters and even other technological disasters in that there is no immediate loss of human life and the acute phase of the event usually unfolds over a much longer period of time" (Palinkas, 2012, p. 204). Oil spills can cause a chronic negative impact on the psychological health of the affected individuals and communities (Erikson, 1994). Recent studies have examined the immediate consequences of the Spill (Shultz, Walsh, Garfin, Wilson, & Neria, 2015). However, very few studies have examined its long-term psychological consequences (e.g., the relationship between uncertainty and PTSD). This study tests how the passing of time would affect the relationship between uncertainty and PTSD. Therefore, the following hypothesis is advanced:

H7: As the residents perceive greater uncertainty about the Spill, they will report more frequent occurrences of PTSD.

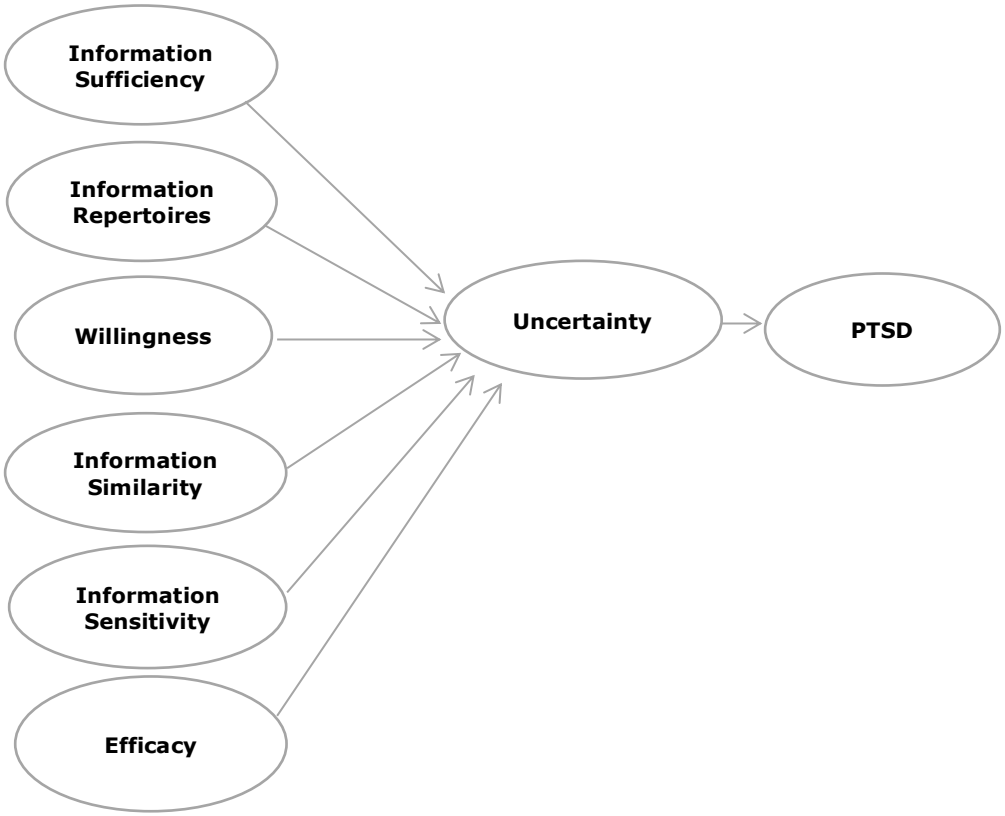

Figure 1. Conceptual framework of the influence of information factors on the relationship between uncertainty and PTSD.

Methods

Participants and Sampling

A cross-sectional survey research study was conducted in the Houston Ship Channel area. A random sample (N = 240) was drawn from the residents in four representative cities of the Houston Ship Channel area (i.e., Texas City, Port Bolivar, Bay Town, and Galena Park) in 2017–2018. Randomly selected residents were eligible to participate in the survey if they were 18 years or older, understood English, had no cognitive impairment, and were exposed to the Spill. There were 121 male and 119 female participants; almost half of the participants were Caucasian Americans (n = 116, 48.3%). Table 1 presents the demographic characteristics of the sample.

Table 1. Descriptive Statistics of the Demographic Characteristics of the Study Sample (N = 240).

	n	%
Gender		
Male	121	50.4
Female	119	49.6
Age (years)		
18–24	34	14.2
25–34	26	10.8
35–44	32	13.3
45–54	34	14.2
55–64	49	20.4
65 or older	64	26.7
Race/ethnicity		
Caucasian	116	48.3
African	46	19.2
Hispanic	61	25.4
Asian	4	1.7
Other	7	2.9
Refused	6	2.5
Education		
Attended high school	18	7.5
High-school graduate	86	35.8
Some college	62	25.8
College graduate	48	20
Postgraduate	24	10
Refused	2	0.8
Household income		
<$50,000	94	39.1
$50,001–$75,000	35	14.6
$75,001–100,000	22	9.2
$100,001–125,000	18	7.5
>$125,000	20	8.3
Don’t know/refused	51	21.3
Marital status		
Yes	146	60.8
No	92	38.3
Refused	2	0.8
Employment		
Full-time	139	57.9
Part-time	29	12.1
Not employed	72	30

Survey Procedure

Survey data were collected via a local professional telesurvey company using the technique of random digit dialing. The survey company handled all the requirements of the current surveys (e.g., filtering of location and exposure to the Spill). The questionnaire was completed by the participants in 15–20 minutes. The research protocol received Institutional Review Board (IRB) clearance from the researchers' university.

Measures

This section describes the measurements for the following variables: Symptoms of PTSD, uncertainty, information source repertoires, information sufficiency, information sensitivity, information similarity, efficacy in information seeking, and willingness to accept information. All variables were measured on a Likert-type scale.

Symptoms of PTSD

The Post Traumatic Stress Disorder Reaction Index (Vernberg, La Greca, Silverman, & Prinstein, 1996), originally a 20-item self-report measure of PTSD symptoms, was adapted in numbers (8 items) and content (oil spill) to screen the prevalence of symptoms of PTSD among the sampled individuals. Respondents assessed the extent of their feelings about the Oil Spill on a 5-point scale ranging from 1 = *Not true* to 5 = *Extremely true* (e.g., "In the past years, I often think about the oil spill, even if I do not want to"). Higher scores indicate that participants were more likely to have symptoms of PTSD.

Uncertainty

Participants rated their level of agreement on a 7-point scale ranging from 1 = *Strongly disagree* to 7 = *Strongly agree*, with six statements in the following areas: Information accuracy and confidence in predicting cleanup issues, cultural impacts, economic impacts, litigation, and health impacts (Nathan et al., 1992). A sample statement is: "I felt I could predict accurately how the oil spill would affect public health." The lower the score, the more uncertainty participants had about the crisis situation. Uncertainty was included as a latent variable in the model.

Information Repertoires

Respondents recalled how frequently they used each source to seek information related to the Spill when they heard or learned about the Spill (Sommerfeldt, 2015). The major sources are categorized into news media (5 items; e.g., television, radio, newspapers, websites of news organizations, websites of non-news organizations, e.g., the Red Cross), social media (11 items; e.g., Facebook, Twitter, Instagram, Snapchat), governmental agencies (3 items), face-to-face conversations with friends, family, and community members (1 item), telephone calls from friends, family, and community members (1 item). Responses ranged from 1 = *Very rarely* to 5 = *Very often*. The summary score of information repertoires was first calculated and included in the model. The summary score of information repertoires was not a significant predictor of uncertainty. Therefore, the mean score for each major source (e.g., social media,

news media, face-to-face conversations) was calculated. These mean scores were included in the model as measured variables.

Information Sufficiency

Respondents rated their satisfaction with the amount of information they had for each of the 16 information types (health, food, safety, etc.) within the first year of the Spill (Sommerfeldt, 2015). Responses ranged from 1 = *Not enough* to 4 = *More than enough*. Sample questions included "For information that you obtained about the Oil Spill, was information sufficient for you to address the concerns related to health?" The mean score of information sufficiency was included in the model as a measured variable.

Information Similarity

Residents estimated the extent to which they thought the Spill communicator (*on various sources*) was similar to their demographic background in terms of race/ethnicity, age, gender, income, and education (5 items; Heath et al., 2009). Response choices ranged from 1 = *Very dissimilar* to 7 = *Very similar*. Sample questions included "How similar do you think the communicator/people/information source was to you in terms of your race/ethnicity?" Source similarity was a latent variable in the model.

Information Sensitivity

Residents were asked to respond to the extent to which they thought the information (on various sources) was sensitive to their demographic background in terms of race/ethnicity, age, gender, income, and education 1 = *Very insensitive to* 7 = *Very sensitive* (5 items; Heath et al., 2009). Sample questions included "How sensitive do you think the information or message was to your race/ethnicity?" Information sensitivity was a latent variable in the model.

Efficacy in Information Seeking

Residents were asked how well they were prepared to handle information seeking on five items in such a major disaster as the Deepwater Horizon oil spill (Heath et al., 2009). Response choices ranged from 1 = *Strongly disagree* to 7 = *Strongly agree*. Sample statements included "I was well prepared to find useful information quickly about an emergency situation such as a major oil spill nearby." Efficacy was a latent variable.

Willingness to Accept Information

Residents indicated on a 7-point scale ranging from 1 = *Strongly disagree* to 7 = *Strongly agree* about their willingness to accept information from various sources about the Spill (6 items; Health et al., 2009). A sample statement is "I was willing to accept a friend, family, and/or community member's information about the Oil Spill." It was considered a latent variable.

Data Analysis

Descriptive statistics were reported on the variables included in the study. Structural equation modeling (SEM) was used to test the hypothesized conceptual model proposed in Figure 1. Confirmatory factor analysis (CFA) was first conducted for latent variables, including uncertainty, PTSD, information similarity, message sensitivity, willingness to accept information, and efficacy in information seeking, to ensure that the proposed factor solutions were adequate. The proposed structural models were then tested. A nonsignificant chi-square, the comparative fit index (CFI) > 0.90, and the root mean square error of approximation (RMSEA) **<** 0.05 suggested a good model fit, but 0.05 **<** RMSEA **<** 0.08 was considered acceptable (Byrne, 2016). SPSS 26 and AMOS 26 were used for data analysis.

When conducting CFA analysis, some error terms within each latent variable, including uncertainty, PTSD, source similarity, information sensitivity, willingness to accept information, and efficacy in information seeking, were correlated to improve model fit according to the suggestions of modification indices (MI). MI, a function in AMOS, indicates what possible paths can be added to the model to reduce the chi-square value of the overall model fit. The error terms are the unexplained variance and measurement error of variables. The suggested correlations were theoretically logical, so they were added. All the final CFA models of latent variables had favorable fit indices. All factor loadings were greater than .50 for all models. The Cronbach's alphas ranged from .81 to .94 for all latent variables (Table 2).

The proposed structural model produced $\chi^2 = 2811.84$ ($df = 924$, $p < .001$), CFI = 0.74, and RMSEA = 0.092 (95% confidence interval [CI]: .089–.096), indicating that the model needed to be improved. Therefore, the variables that did not have significant relationships with uncertainty, including information sensitivity and information repertoires such as social media, face-to-face conversations with friends, family, and community members, telephone calls from friends, family, and community members, and local governments, were deleted from the model. Information from news media was still kept in the model because it had a marginally significant relationship with uncertainty. Modification indices indicated that adding correlations between information from news media and information sufficiency as well as between information similarity and efficacy in information seeking would improve the model fit. The suggestions were theoretically reasonable. For example, Lee and colleagues (2020) found that there was a higher frequency of using national and local TV news sources among households during a hurricane evacuation, and, to a large extent, this type of news source would determine how they perceived the amount of information they received. In addition, some recent studies (e.g., Collins, Buchholz, Cranford, & McCrory, 2021; So et al., 2022) have demonstrated that relevant and culturally sensitive messages are more effective in boosting one's self-efficacy and changing behaviors. Therefore, the correlations were added to the model. The final model yielded $\chi^2 = 944.81$ ($df = 507$, $p < .001$), CFI = 0.92, RMSEA = 0.06 (95% CI: .054–.066), indicating a good fit.

Results

Uncertainty, PTSD, Information Sufficiency, Information Similarity, Information Sensitivity, Willingness to Accept Information, and Efficacy in Information Seeking

Participants did not experience much uncertainty (*M* = 4.93, *SD* = 1.64; a higher score means less uncertainty or "more certainty"), and the extent of the symptoms of PTSD that the participants experienced was low (*M* = 1.99, *SD* = 1.08). See Table 2 for descriptive data on information sufficiency, information similarity, information sensitivity, willingness to accept information, and efficacy in information seeking.

Information Repertoires

Participants gained the most information about the Spill from face-to-face conversations with friends, family, and community members (*M* = 3.3, *SD* = 1.39), followed by news media (*M* = 3.14, *SD* = 0.95; see Table 2). Local governments (*M* = 1.66, *SD* = 1.25) and social media (*M* = 1.90, *SD* = 1.24) were the two least sought for sources of information by the participants. Table 3 displays the descriptive data on various sources of news media and social media.

Table 2. Means and Standard Deviations of Information Features, Willingness to Accept Information, and Efficacy in Information Seeking.

	M	*SD*	Cronbach's α
PTSD[a]	1.99	1.08	.89
Uncertainty[b]	4.93	1.64	.88
Information repertoires[c]			.91
News media	3.14	0.95	
Social media	1.90	1.24	
Face-to-face	3.3	1.39	
Telephone calls	2.38	1.40	
Local governments	1.66	1.25	
Information sufficiency[d]	2.77	0.89	.94
Information similarity[e]			.88
Race/ethnicity	3.29	0.98	
Age	3.15	1.03	
Gender	3.22	0.93	
Income	3.06	0.88	
Education	3.21	0.94	
Message sensitivity[f]			.90
Race/ethnicity	3.15	1.01	
Age	3.17	1.04	
Gender	3.03	1.04	
Income	3.06	1.04	
Education	3.14	1.03	

Willingness to accept[g]	5.00	1.36	.81
Efficacy in information seeking[h]	5.67	1.57	.94

Note: [a] 1 = *Not true* to 5 = *Extremely true*; higher score, more symptoms of PTSD;
[b] 1 = *Strongly disagree* to 7 = *Strongly agree*; lower score, more uncertain;
[c] 1 = *Very rarely* to 5 = *Very often*; higher score, more sources;
[d] 1 = *Not enough* to 4 = *More than enough*; higher score, more sufficiency;
[e] 1 = *Very dissimilar* to 5 = *Very similar*; higher score, more similar;
[f] 1 = *Very insensitive* to 5 = *Very sensitive*; higher score, more sensitive;
[g] 1 = *Strongly disagree* to 7 = *Strongly agree*; higher score, more willingness;
[h] 1 = *Strongly disagree* to 7 = *Strongly agree*; higher score, more efficacy.

Table 3. Descriptive Statistics of Participants (N = 240) Who Used the Information Repertoires "Often" and "Very Often."

	n	%
News media		
Television	189	78.8
Radio	83	34.6
Newspaper	95	39.6
Internet websites (news orgs)	87	36.3
Internet websites (non-news orgs)	63	26.3
Social media		
Facebook	73	30.4
Twitter	42	17.5
Linkedin	14	5.8
Pinterest	9	3.8
Google	27	11.3
Myspace	10	4.2
Snapchat	11	4.6
Instagram	17	7.1
YouTube	38	15.8
Instant messaging	18	7.5
Blogs	10	4.2
Face-to-face	109	45.4
Telephone calls	51	21.3
Local governments	17	7.1

Predictors of Uncertainty

Information sufficiency (H1; β = .52, p < .001), information similarity (H3; β = .16, p < .05), willingness to accept information (H5; β = .30, p < .001), and efficacy in information seeking (H6; β= .15, p < .05) were significant predictors of uncertainty (see Figure 2). Thus, H1, H3, H5, and H6 are supported. Information repertoire (H2) as a whole was first included in the model, and the results demonstrated that the whole "repertoire" was not a significant predictor of uncertainty. Each of the information sources of

social media, news media, face-to-face conversations, telephone calls, and local governments was then included in the model. No individual information source significantly predicted uncertainty, and only the information source of news media was marginally significantly related to uncertainty ($\beta = -.24$, $p < .07$). Therefore, H2 was not supported. Information sensitivity (H4) was not a significant predictor of uncertainty. The predictors of uncertainty explain 30.4% variances of uncertainty.

Uncertainty and Symptoms of PTSD

H7 tested the relationship between uncertainty and symptoms of PTSD. Uncertainty was a significant predictor of the symptoms of PTSD ($\beta = -.20$, $p < .01$); therefore, H7 is supported. However, uncertainty explains only 3.6% variances of PTSD tied to the Spill.

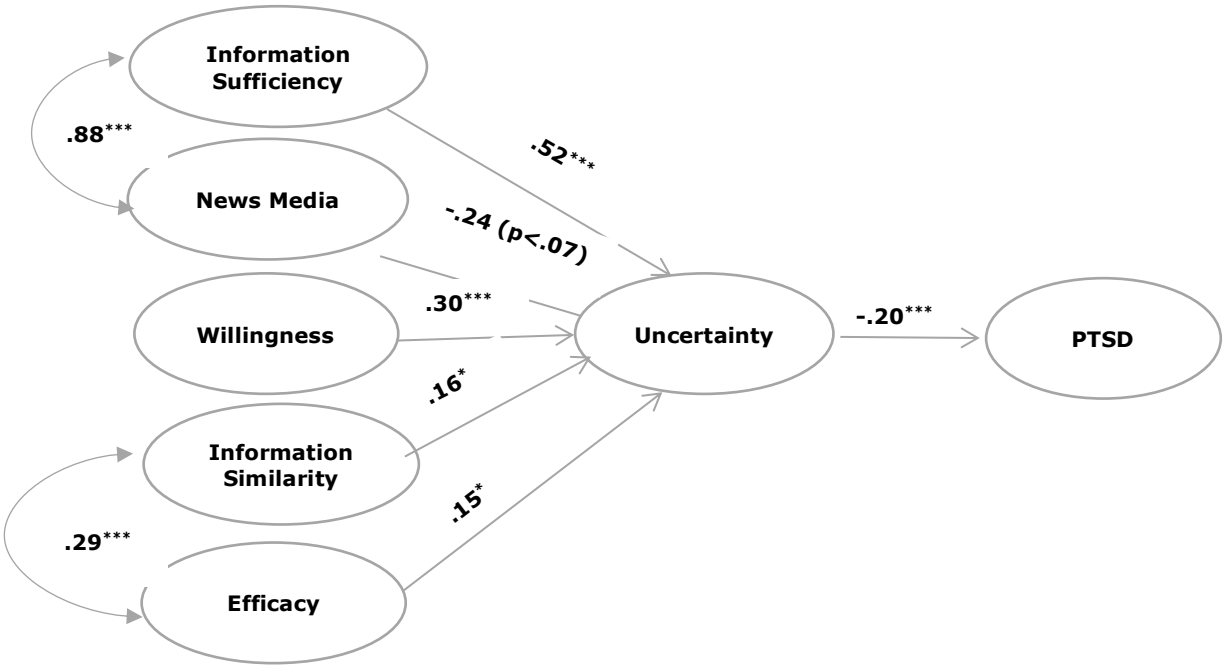

Figure 2. Results of SEM analysis: Significant paths with standard coefficients.
Note. * $p < .05$, ** $p < .01$, *** $p < .001$.

Discussions

This study examined how information features and personal characteristics are associated with different levels of uncertainty developed in communities during the Deepwater Horizon oil spill in 2010. We also examined how uncertainty is associated with symptoms of PTSD that developed in the aftermath of the Spill.

Information Repertoires

Participants in this study gained information about the Spill more often from television and face-to-face conversations with their friends, family, and community members. These findings are consistent with Lee and colleagues (2020) and Spence, Lachlan, and Griffin (2007), who found that television is still the primary source of crisis, as well as Lee and colleagues (2020) and Spence, Lachlan, Burke, et al. (2007), who demonstrated that individuals also often use personal sources such as friends and neighbors to gain information about crises. Face-to-face conversations with such sources were critical to understanding what was going on during Hurricane Katrina. Information from newspapers, Internet websites of news organizations, and radio was also frequently used by the participants to make sense of the ongoing events.

However, social media, along with local governments, were not a primary source used by the participants in this study to gain information about the Spill. Facebook (30.4%) was the only social media type that was relatively frequently used. Consistent with Lee and associates (2020), these findings indicate that traditional news media and interpersonal communication remain the most accessible, reliable, and resilient information sources among the residents of the Houston Ship Channel area when they were experiencing the Deepwater Horizon oil spill. News and information on social media are usually diffused without gatekeeping (Chew, Mohamad, & Salleh, 2019), which might downplay the credibility of the information, especially in a crisis situation. Despite the recent chorus that social media are a rising and promising platform that could replace traditional media in sharing and obtaining news and information (Chew et al., 2019), this study found social media are unlikely to replace traditional channels of communication during crises. The little use of government sources of information is consistent with a recent finding that the publics are reluctant to seek information from government entities in coping with disasters unless the publics have established quality relationships with them (i.e., shared trust, commitment, control, and satisfaction; Liu & Ni, 2021).

It is interesting to note that none of the sources in information repertoires was a significant predictor of uncertainty, and only news media were marginally significantly related to uncertainty. Furthermore, the marginally significant relationship was negative ($\beta = -.24$, $p < .07$), which means more information from news media was related to increased uncertainty about the crisis among the participants. These results demonstrate that the information received by the participants might not be both adequate in quantity and appropriate in content.

Information Sufficiency

Most participants of the current study did not feel they received enough information about the Spill. However, information sufficiency did bear a significant negative relationship with uncertainty. The more information the participants had about the Spill, the less uncertainty they experienced. Although this finding is not consistent with Lee and colleagues (2020), who found that the amount of information did not predict uncertainty, it is consistent with Griffin and associates (2004), who stated that the amount of information influences the strategies people use to process crisis-related information. They further claimed that when there is a gap "between what people believe they know about a risk and what they think they need to know to cope with it in their daily lives" (Griffin et al., 2004, p. 51), they experience information *in*sufficiency.

Therefore, more information was probably needed from traditional news media (which were used more often by participants in this study) about the Spill. Given the mixed findings regarding the predictive ability of the information amount on uncertainty, more research is needed in this area.

Information Similarity and Information Sensitivity

Another reason for the perception of information insufficiency mentioned above may stem from the lack of personal relevance perceived by the participants (rather than due to their ability to process information) because most participants of this study were self-confident about their ability to gather and understand information, and they were strongly motivated/willing to accept the information from the available and accessed sources. Higher perceived relevance would make people believe and trust the message more, and higher levels of information similarity and message sensitivity can produce a higher level of perceived message relevance (O'Reilly et al., 2016). In this study, the majority of the participants were not sure if the sources/communicators of the information they received were similar or sensitive to their race/ethnicity, age, gender, income level, and education level. Nevertheless, information source similarity (β = .16, p < .05) was a significant predictor of uncertainty. That is, when people perceived information sources were more similar to them demographically, they were more likely to experience less uncertainty. However, perceived message sensitivity in this study was not related to decreased uncertainty among the residents as hypothesized. These findings were partly and indirectly supported by Heath and colleagues (2009) and Huang and Garcia (2020), who found that the more similar the information sources are to people (at the surface structure level), the more likely they are to comply with the advice presented in the information. When people are more willing to accept information or comply with advice in information, they are more likely to feel they have the knowledge to deal with the crisis situation, which would reduce any uncertainty they experience. However, the findings were also partly inconsistent with Heath and associates (2009), who stated that information similarity would lead to perceived message sensitivity among the residents in crisis, and "when people perceive that messages are more sensitive to them, they are more likely to comply with the advice" (p. 138). One possible explanation might be that the majority of the participants were Caucasian (n = 116, 48.3%), and there were not many variations in participants' responses to the question related to information sensitivity. More research is needed to examine perceived information similarity and sensitivity among minority people. Furthermore, crisis communication should be targeted at or tailed for the intended audience so that they feel that the information source is similar, sensitive, and relevant to them.

Willingness to Accept Information and Efficacy in Information Seeking

An individual's willingness to accept information (β = .30, p < .001) and efficacy in information seeking (β = .15, p < .05) were significant predictors of uncertainty. The more the people were willing to accept information from various sources during the Spill, the lower the levels of uncertainty they experienced. The higher perceived efficacy in information seeking was related to the lower uncertainty among the residents affected by the Spill. These results are consistent with Ju and colleagues (2022) and van Lieshout and associates (2021) and can be explained by Bandura's (2001) social cognitive theory, which recognizes the value of motivation and self-efficacy. Motivation generally refers to the internal force or drive that "instigates one to engage in a particular behavior" (Shahsavari, Shahriari, & Alimohammadi, 2012, p.

319). In this study, motivation or willingness to accept information instigates people to process information systematically, which would, in turn, help reduce uncertainty. Self-efficacy refers to a person's perceived ability to carry out a particular task efficaciously. When a person has high self-efficacy, he or she has the competence to face challenges and reach behavioral goals (Bandura, 2001). When participants of this study perceived they had confidence in gathering and understanding information about the Spill, they had the competence or ability to understand the crisis situation, which would also, in turn, lead to decreased uncertainty. Therefore, when communicating crisis information, the information source or communicator should be aware of the factors that motivate people to accept information and boost their efficacy in information seeking or processing, which are essential in reducing potential uncertainty developed during crises. In addition, this study found that information similarity was significantly correlated with efficacy, which is consistent with Heath and associates (2009), who stated that a crucial factor in the willingness to follow expert advice or accept the information is the similarity between the source and the recipients of the information.

Uncertainty and PTSD

The residents along the Houston Ship Channel reported few symptoms of PTSD. When observed after seven years of the Spill, the PTSD level was low (M = 1.99, SD = 1.08, on a 5-point scale with lower scores indicating fewer symptoms of PTSD). This finding is not consistent with Drescher, Schulenberg, and Smith (2014), who found that rates of PTSD symptoms in relation to the Deepwater Horizon oil spill were high in the coastal counties of Mississippi. One possible explanation is that residents in this study were not impacted as much by the Spill. Another possible explanation is that time heals all wounds, and people's psychological trauma may have dulled by 2017 (i.e., 7 years after the Spill), when the survey was conducted.

In contrast, the participants in this study reported that they experienced a certain degree of uncertainty about the environment, the economy, the cleanup efforts, local culture, litigation, and public health. However, the level of uncertainty was not expansive. To some extent, this finding is in line with what Gill, Picou, and Ritchie (2012) and Palinkas (2012) claimed: Technological disasters tend to create chronic uncertainty about health and the community environment. This finding is also consistent with Cherry and associates (2015), who found that uncertainty about the negative consequence of the Deepwater Horizon oil spill was common among commercial fishermen who were exposed to the Spill.

The results of this study suggest that the higher level of uncertainty the participants experienced during the Spill, the more likely they were to have developed symptoms of PTSD. This finding is also consistent with previous literature, which stated that lower tolerance of uncertainty is associated with greater/increased PTSS and PTSD (Jung et al., 2022; Paltell et al., 2022).

The above findings make sense when they are related to the uncertainty-reduction theory (Berger, 1986), which states that people would seek more information to reduce uncertainty developed due to lack of information. And reduced uncertainty will then be linked with fewer symptoms of PTSD (Jung et al., 2022; Paltell et al., 2022). The level of uncertainty reported by the participants in this study might have already become low (e.g., due to information-seeking behavior or time lapse) compared with the initial uncertainty level immediately after the crisis, which would lead to less PTSD. This finding indicates longitudinal studies

are urgently needed to examine the relationship between uncertainty and PTSD. Uncertainty levels should be measured at multiple time points during a crisis situation, and the differences among these multiple time points can be employed to investigate the relationship between uncertainty and PTSD.

The current COVID-19 pandemic stories from mass media, social networking sites, family members, neighbors, and others evoke worries, uncertainties, and/or other negative thoughts that may significantly contribute to mental health, including anxiety, depression, and symptoms of PTSD. By listening to and seeking COVID-19-related stories, we are essentially persuaded into certain psychological or mental states. The findings of this study should help understand how the information factors related to the COVID-19 pandemic and the uncertainties created by this pandemic have impacted mental health among the public.

Limitations and Suggestions for Future Studies

A notable limitation is that the study used cross-sectional data. Therefore, no causal relationships could be claimed between the predictors and uncertainty. Also, this study only included the residents in the Houston Ship Channel area, therefore, caution should be exercised while generalizing the findings or extrapolating them to other populations and crisis events. Second, the current study used self-reported perceptions to measure information sufficiency, information repertoires, information similarity and sensitivity, willingness to accept information, and efficacy in information seeking. Participants might have different understandings of and criteria for reporting their perceptions, and some people might not be able to differentiate between some response options (e.g., enough vs. more than enough). Therefore, future studies can develop more fine-tuned measures to assess these information features. Third, the current study did not differentiate between the surface structure and the deep structure to measure source similarity and message sensitivity. Future studies need to develop disaggregated items for the surface and the deep cultural structures to assess source similarity and message sensitivity. Finally, participants were asked to recall memories about the Spill, which happened seven years ago. Therefore, memory bias or errors could have occurred when participants pulled things from the storage of memories. Future studies can conduct trend analysis on how information features of crisis communication are related to uncertainty about crises and how uncertainty is related to possible symptoms of PTSD by collecting data at multiple time points.

Overall, the current study signifies the importance of information sufficiency, information similarity, the willingness of people to accept information, and efficacy in information seeking in facilitating risk messages to be absorbed into a community and in reducing uncertainty developed during crisis situations. More research is needed to investigate the relationship between uncertainty and symptoms of PTSD during and after crisis situations.

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