

Tsunami Warning Message Interpretation and Sense Making: Focus Group Insights

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ABSTRACT

Hazard warning messages are intended to shift people from a sense of safety to a sense of risk, while providing guidance for protective action. Message features, such as the content elements that are included and the style in which a message is written or delivered, can strengthen or weaken a recipient's ability to make sense of and act on the message. Under conditions of heightened uncertainty or imminent threat the strategies that people apply to interpret warning messages may make a difference in the protective actions that they choose to take. Importantly, when a hazard is unfamiliar and the threat is imminent, adequate mental models and clearly articulated messages become vital to one's ability to make decisions about life safety. To better understand the message interpretation and the effects of message sense making on individual risk information processing, this article assesses warnings for an infrequently experienced threat: tsunamis. Using data from four focus groups this research finds that individuals engage in interpretive sense making activities by making comparisons to media accounts of tsunamis and drawing from personal experience with waves and with warnings for other hazards, particularly tornadoes. The analysis presents three primary insights: 1) hazard warning messages must be designed for the end user in mind, including those who are unfamiliar with the hazard; 2) clear and specific information helps to personalize the threat and to reduce anxiety; and 3) message receivers draw from personal and vicarious experiences to assist in message sense making, highlighting the need for consistent language across hazard warnings.

1. Introduction

The goal of an effective hazard warning message is to shift individuals from a sense of safety to a sense of risk, and to guide people to make wise choices in the face of danger.¹ Decades of research have resulted in the identification of key messaging elements that increase the likelihood that people will take protective actions. Message features, such as the content elements that are included and the style in which a message is written or delivered, can strengthen or weaken a recipient's ability to make sense of and act on the message. Under conditions of heightened uncertainty or imminent threat the

strategies that people apply to interpret warning messages may make a difference in the protective actions that they choose to take. Importantly, when a hazard is unfamiliar and the threat is imminent, adequate mental models (Wood et al. 2012; Lazrus et al. 2016) and clearly articulated message contents become vital to one's ability to make decisions about life safety.

What is of critical importance, but missing from investigations of public responses to warning messages, is an examination of how message sense making supports individual risk processing strategies and message interpretation. This study investigates these two processes and reports the findings from four focus group interviews, including 31 participants, on message interpretation and information processing in response to an unfamiliar hazard scenario (a tsunami). We build on the extensive groundwork of social science research on how to effectively communicate warning information to the public (Mileti and Sorensen 1990) and apply it to a threat for which little public communication research has been conducted (Lindell and Prater 2010). In doing so, we identify a set of sense making strategies utilized

¹ We distinguish hazard warning messages from hazardous substance messages, noting that the message content is likely to differ between these two types of warnings.

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by message recipients in order to quickly process risk information. We demonstrate the importance of language specificity and clear message content for *unfamiliar hazards* and the importance of warning language consistency *between and across* hazard types. The findings from this research have the potential to inform future warning strategies across a variety of hazard types.

2. Literature review

a. Public warning: Interpretation and response

Tsunamis occur infrequently. However, when they do occur, the results can be devastating. Recent tsunamis include the Boxing Day Tsunami in Aceh Indonesia on 26 December 2004, which killed hundreds of thousands; the 2010 Chilean earthquake and tsunami, which resulted in hundreds of deaths; and the 2013 Tohoku earthquake and tsunami, which killed nearly 16 000 persons (CNN Library 2013).

Tsunamis pose the greatest risk to those living and working along coastal areas. However, even island populations, especially those with little historical experience of tsunamis, have demonstrated a lack of knowledge of tsunami threat (see Perry 2007) and ability to interpret environmental cues (Gregg et al. 2006). Even individuals who are routinely at risk from tsunamis have limited understanding of alert and warning sirens (Gregg et al. 2007), warning messages (Perry 2007), and protective actions they should take in response to tsunami warnings. Findings from these studies provided some impetus for the expert evaluation of tsunami warning messages (Gregg et al. 2007) and highlighted a recognized need for message testing among populations who are vulnerable to tsunami (Lindell and Prater 2010) in order to determine how to craft messages that will be easily interpreted and compel individuals to take protective actions.

Message interpretation includes an interconnected series of sociopsychological activities that occur between the receipt of a warning and initiating protective action. Research findings suggest that this is an iterative process that shapes perceptions and includes the stages hear, perceive (understand, believe, and personalize), and respond (Mileti and Peek 2000). *Understanding* results from attaching meaning to the information and often varies among message receivers. *Believing* in the risk information is to trust that what is being communicated is true and that it is accurate. Message *personalization*, also called situational risk perception, includes identifying that the message is indeed meant for the receiver and that the receiver is at risk (Mileti and Sorensen 1990). Throughout the warning period, the message receiver, if he or she is able, will often actively

seek additional information to *confirm* the warning (Drabek 1969). Taken together, along with other situational and contextual factors, these sociopsychological activities will lead to a decision to respond to the risk.

Decades of research on public responses to alerts and warnings has resulted in a catalog of message contents that have the greatest effect on promoting protective actions among the public (Mileti and O'Brien 1992; Lindell et al. 2016), particularly for those who do not have adequate mental models from which to make decisions about protective actions (Lindell et al. 2015; Eiser et al. 2012). Key warning message contents include information about the hazard, location of impact, protective action guidance, the source of the message, and the time by which action should be taken.

Effective messages must contain information about the *hazard*, including a description of physical characteristics of the threat, its potential effects and impact, and an explanation about why the hazard poses a threat to the public's safety (Drabek 1999; Mileti and Peek 2000). Ambiguous messages (those that fail to adequately specify and define a hazard) are likely to result in inconsistent message understanding among individuals (Mayhorn and McLaughlin 2014) and minimize perceptions of risk (Drabek 1999). Warning messages should also provide *guidance* so individuals know what actions to take to increase their safety, and how to perform these actions (Mileti and Sorensen 1990). Effective guidance will detail the essential steps to be taken to protect life and property (Lindell and Perry 1992) in an instructive manner, explaining how to perform life-saving activities (Sellnow et al. 2002). Public warning messages must also identify the *location* of the impending hazard and the areas at risk. This includes geographical and physical boundaries for the at-risk area so individuals within that area can evacuate or prepare to do so (Greene et al. 1981) and those who are safely outside of the hazard area know to avoid it (Mayhorn and McLaughlin 2014) for their own safety as well as to prevent clogging evacuation routes (Dow and Cutter 1998). Messages should also contain information about *time*, indicating when individuals should initiate protective actions (Drabek and Boggs 1968; Perry et al. 1980; Mileti and Sorensen 1990) and how much time they have to do so. And finally, messages must also indicate the *source* (or sources) of the warning; that is the agency, organization, or individual who is initiating warning communication (Mayhorn and McLaughlin 2014).

The style in which a warning message is delivered will also affect message interpretation (Mileti and Peek 2000). The most effective public warnings will provide content about the hazard, location, guidance, and time in a manner that is *specific, consistent, certain, clear, and accurate*.

Specificity refers to precision and detail about the hazard impact, guidance (protective action), and location of the threat (Mileti et al. 1990). Message specificity affects the public's response (Quarantelli and Dynes 1977); vague messages are likely to result in differing interpretations (Mayhorn and McLaughlin 2014; Mileti and Peek 2000) and minimization of risk (Drabek and Boggs 1968) and may place at-risk populations in greater danger (Bean et al. 2015). Messages that specify the location of the hazard often result in higher levels of personalized risk (Mileti and Peek 2000), affecting intent to take action. Warning content should also be *clear*, comprising simple, straightforward language that the general public is able to understand and respond to (Quarantelli 1984). Content that is unclear or ambiguous reduces understanding (Drabek and Stephenson 1971) whereas content that is clear and specific will increase understanding.

Warnings must also ensure information is *consistent* within and across a series of messages (Mileti and Sorensen 1990). While inconsistencies generally arise as new information surfaces about a hazard and information is updated (Mileti and Peek 2000), consistency can be achieved through repetition of the most recent message, inclusion of changes in the situation, and explaining why the situation changed. Message sources should also demonstrate *certainty* about the content of the warning, including information about the hazard, guidance, and location (Mileti and Sorensen 1990; Perry 1979), even when hazard impact may be uncertain (Mileti and Peek 2000). Certainty has been linked to believability in flood warnings and evacuations (Mileti and Beck 1975) and to public response in earthquake messaging (Mileti and O'Brien 1992). And finally, messages must be perceived as *accurate*, based upon information that is both timely and complete (Mileti and Sorensen 1990). If individuals believe they are not receiving the whole truth, they may not believe the message, may discount the credibility of its sources, and may not adhere to the message or future messages (Mileti et al. 1975).

Much research has been conducted on warning message effectiveness across a variety of hazard types including earthquake (Mileti and O'Brien 1992), flood (Parker et al. 2007; Becker et al. 2015; Perry et al. 1981), hurricane (Baker 1991; Huang et al. 2016), volcanic eruption (Perry and Greene 1983; Leonard et al. 2008), and tornado (Lindell 2012). However there has been a lack of research on public perceptions of tsunami warning messages,²

making this an understudied topic, especially in the context of the United States. Therefore, we pose the following questions:

RQ1: How do the content and style characteristics of the warning message influence the receiver's *understanding* of the tsunami message?

RQ2: How do the content and style characteristics of the warning message influence the receiver's *belief* in the tsunami message?

RQ3: How do the content and style characteristics of the warning message influence the receiver's *personalization* of the tsunami message?

b. Warning message processing and sense making

Knowing *what* message receivers understand, believe, and personalize as a result of a warning message provides insight into the specific content and style of that message. Identifying *how* individuals come to interpret a message and what strategies they use as they process imminent threat information provides insight into warning message sense making.

Sense making is a process of social construction (Berger and Luckmann 1967) in which individuals attempt to interpret and explain sets of cues from their environments or experiences. Sense making activities are particularly important in dynamic and turbulent contexts (Sellnow et al. 2002; Weick 1993) during which people must deal with uncertainty and ambiguity (Maitlis 2005). This is especially important in disaster or crisis contexts when there is a critical need for almost immediate, accurate information (Seeger et al. 1998).

Research on sense making has focused largely on how organizations (Weick 1993) and individuals (Dervin and Naumer 2010) process information in response to changing conditions, with an emphasis on how "gaps" in understanding are navigated. In unfamiliar contexts, such as under threat of an uncommon hazard, gaps in understanding are likely to exist (Perry 2007; Lindell et al. 2015). Sense making, or information processing, has been linked to a variety of techniques when individuals are presented with unfamiliar situations or insufficient information. One strategy, for instance, is to draw upon an easily available memory or experience to make evaluations and decisions. The ease by which one is able to recall an event may be influenced by instances of a relevant event occurring in one's social network, such as friends, family, and acquaintances (Hertwig et al. 2005), or instances of a relevant event presented in the media (Pachur et al. 2012), such as movies and news. Research has demonstrated that judgments, perceptions, and sense making processes about ambiguous information are "dominated by the content that is most

²One study commissioned by National Oceanic and Atmospheric Administration (Gregg et al. 2012) was conducted with experts and community stakeholders to assess tsunami message contents, resulting in recommended changes. Our study complements this research by focusing on members of the public.

accessible at the time of the evaluation” (Geurten et al. 2015, p. 405).

Importantly, an individual’s experience with one risk can transfer to his or her response to other risks (Johnson and Tversky 1983) and people draw from past situations as an initial guide to define a new situation (Grunig 1983). Thus recalling relevant hazard experience (Griffin et al. 1999) may serve as another strategy for sense making.

Because of the infrequency of tsunamis and their localized impact, individuals who lack a personal experience of tsunamis are likely to draw from events that they can recall and other types of experiences that appear to be salient to their current circumstances. Therefore, we pose the following question:

RQ4: How do message receivers make sense of/process the risk information in the tsunami warning message?

3. Methods

Focus groups are useful because they allow researchers to obtain multiple perspectives about the same topic and shared understandings about the ways in which individuals are influenced by a situation (Gibbs 1997). They are not intended to generate comprehensive or generalizable data or to indicate consensus on particular ideas (Lazrus et al. 2012). However, the interactions among group members enable comparative descriptions, or the identification of major themes that emerge from the data. Four focus groups, totaling 31 participants, were conducted in Lexington, Kentucky, in October 2014. Lexington was selected because of its landlocked location and a strong likelihood that group participants would be personally unfamiliar with threats associated with tsunamis. Therefore, this population represents potential vacationers to tsunami-prone locations (coastal areas) that might receive tsunami warnings but have no prior experience with such a hazard.

Group participants were recruited by a third-party vendor in Lexington, Kentucky, that conducts marketing research, using their existing consumer panel. Participants varied in age (25–72), gender (16 female), ethnicity (5 African American, 1 Native American, 26 Caucasian); education level (10 high school, 13 bachelor’s degree, 9 graduate school); and occupation. None of the 31 participants had any direct personal experience with tsunamis.

Group sessions began with each participant providing written informed consent allowing for audio recording. Each of the four focus groups was presented with a

tsunami message (a Special Weather Statement from the National Weather Service; see Fig. 1) that had not been altered except for the date of the message (changed to match the date of the focus group). Participants were asked to imagine that they were on vacation and had driven a rental car to the town of Eureka, California, a coastal area that has experienced prior tsunamis. When they arrive near the beach in Eureka, their cell phone alerts them to a message from the National Weather Service.

The complete message (totaling 12 paragraphs of content) was discussed sequentially, in smaller sets of two to three paragraphs each, with focused discussion in between. The warning message was broken into smaller sets and discussed sequentially in an effort to narrow and focus the conversation. Discussions occurred four times. Prior to each discussion period, participants were given paper copies of the paragraphs. The focus group moderator then read them out loud while participants followed along. Each discussion period included four primary questions in response to those paragraphs: 1) Do you understand this message? 2) Do you believe this message? 3) Do you think this message impacts you specifically? and 4) What will you do next? For all questions, discussion probes focused on message content elements including source, hazard, guidance, location, and time. At the conclusion of each focus group, individuals were given paper copies of the complete message, asked to circle concepts or statements that they did not fully understand, and then return those copies to the group moderator.³

Detailed notes were taken throughout the focus groups and each session was audio recorded and transcribed. Initial content analysis included proofreading the material, and underlining key sections and phrases while referencing the detailed notes that were made throughout the focus groups (Sandelowski 1995). A deductive approach to content analysis was used (Burns and Grove 2005), drawing from the constructs about warning interpretation, response, and sense making previously described. Using Excel spreadsheets, content coding was then independently conducted by two researchers to identify participant statements referring to their message interpretation, including understanding, believing, personalization, and behavioral intent. These statements were simultaneously associated with one or more codes representing the message content elements (hazard, source, guidance, time, and location), as well as style features (specificity, consistency, certainty, clarity,

³ Marked up copies of the messages were used to aid in a message redesign for subsequent experimental research.

WWUS86 KEKA 111820
 SPSEKA
 SPECIAL WEATHER STATEMENT
 NATIONAL WEATHER SERVICE EUREKA CA
 1020 AM PST FRI OCT 11 2014

CAZ001-002-120030-
 REDWOOD COAST-MENDOCINO COAST-
 1020 AM PST FRI OCT 11 2014

...A TSUNAMI WARNING REMAINS IN EFFECT FOR DEL NORTE...HUMBOLDT AND
 MENDOCINO COUNTIES COASTAL AREAS...

EARTHQUAKE DATA. PRELIMINARY MAGNITUDE 8.9. LOCATION 38.2 NORTH 142.5
 EAST. NEAR EAST COAST OF HONSHU JAPAN. TIME 21:46 PST MAR 10, 2015. A
 TSUNAMI WAS GENERATED AND HAS CAUSE DAMAGED ALONG THE DEL NORTE
 COUNTY, AND DAMAGE ALONG THE HUMBOLDT AND MENDOCINO COASTS IS
 STILL EXPECTED. PERSONS AT THE COAST SHOULD BE ALERT TO INSTRUCTIONS
 FROM LOCAL EMERGENCY OFFICIALS.

DAMAGING WAVES HAVE BEEN OBSERVED ACROSS HAWAIIAN ISLANDS.
 DAMAGING WAVES HAVE ARRIVED AT CRESCENT CITY HARBOR WHERE ALL
 DOCKS HAVE BEEN DESTROYED. WAVES HAVE BROKEN OVER THE SPIT AT
 STONE LAGOON. A 3-FOOT WAVE HAS BEEN REPORTED IN HUMBOLDT BAY. A 2-4
 FOOT FLOOD WAVE WAS REPORTED MOVING UP THE MAD RIVER AT 08:45 AM
 PST. DAMAGING WAVES WILL CONTINUE FOR THE NEXT SEVERAL HOURS.

MEASUREMENTS OR REPORTS OF TSUNAMI WAVE ACTIVITY GAUGE LOCATION
 TIME AMPLITUDE
 CRESCENT CITY, CA 08:44 AM 8.1 FT, NORTH SPIT HUMBOLDT 8:30 AM 3.1 FT,
 ARENA COVE 09:17 AM 5.3 FT.

REMEMBER...DON'T BE FOOLED...TSUNAMI WAVES CAN SEEM STOP FOR LONG
 PERIODS AND THEN BEGIN AGAIN. WAIT FOR THE OFFICIAL ALL CLEAR TO
 RETURN TO THREATENED AREAS.

IN DEL NORTE COUNTY...PEOPLE ARE ORDERED TO EVACUATE TO ABOVE 9TH
 STREET. SHELTER LOCATIONS INCLUDE SMITH RIVER ELEMENTARY...DEL
 NORTE HIGH SCHOOL AND YUROK TRIBAL OFFICE IN KLAMATH.

IN HUMBOLDT AND MENDOCINO COUNTIES...PEOPLE ARE ADVISED TO STAY OFF
 BEACHES...NOT TRAVEL BY WATERCRAFT AND EVACUATE LOW LYING
 COASTAL AREAS IMMEDIATELY UNTIL ADVISED THAT IT IS SAFE TO RETURN.

PEOPLE SHOULD STAY CLEAR OF LOW LYING AREAS ALONG COASTAL RIVERS
 AS TSUNAMI WAVES CAN TRAVEL UP FROM THE MOUTH OF COASTAL RIVERS.

BULLETINS WILL BE ISSUED HOURLY OR SOONER IF CONDITIONS WARRANT TO
 KEEP YOU INFORMED OF THE PROGRESS OF THIS EVENT. IF AVAILABLE...REFER
 TO THE INTERNET SITE [HTTP://TSUNAMI.GOV](http://TSUNAMI.GOV) FOR MORE INFORMATION.

DUE TO RAPIDLY CHANGING CONDITIONS ASSOCIATED WITH TSUNAMI WAVE
 ACTIVITY...LISTENERS ARE URGED TO TUNE TO LOCAL EMERGENCY ALERT
 SYSTEM MEDIA FOR THE LATEST INFORMATION ISSUED BY LOCAL DISASTER
 PREPAREDNESS AUTHORITIES. THEY WILL PROVIDE DETAILS ON THE
 EVACUATION OF LOW-LYING AREAS...IF NECESSARY...AND WHEN IT IS SAFE TO
 RETURN AFTER THE TSUNAMI HAS PASSED.

FIG. 1. Special Weather Statement used for focus group discussion.

and accuracy). All codes were deductively drawn from the constructs previously described. A second round of coding was applied to investigate statements about how individual participants came to their message interpretation—how they made sense of tsunami risk

information—through statements about their experiences relative to tsunamis and other threats that they deemed salient to interpreting the warning message. After each round of coding, coders met jointly to discuss areas of agreement and to resolve any disagreements on

codes that were applied. Collectively, 15 codes directly corresponded with our research questions concerning how tsunami message receivers interpret and make sense of a tsunami warning message. Using a “scissor and sort technique” (Stewart and Shamdasani 2015), similarities and differences in participants’ stated responses to each of the message sections were grouped and analyzed for recurring themes in order to answer the four research questions.

4. Findings

This section reports the results of our analysis in relation to our four research questions.

a. RQ1: Understanding the tsunami message

Focus group participants had mixed levels of understanding in response to various sections of the warning message text and articulated a diversity of perceptions and opinions of how tsunamis “work.” In particular, participants expressed that message content about the tsunami was not specific or clear enough about the threat, its potential impact, or the location that was under threat.

For instance, in reference to the size of the wave that was approaching, one participant said “I don’t think that adequately expresses the potential for a tsunami. I mean, ok, a 3 foot wave, awesome. 10 miles across. Could be coming into land for a mile or two miles or whatever.” Another stated “You know, 3 foot, what does that mean? 5 foot—what does that mean? But if you were to tell me it’s damaging waves, I would take that as being more serious.” Yet others indicated that they had limited understanding of the threat in general and asked for more specific information about what they should look out for and what they can expect to experience. For instance, one person said: “What should we look for? [If the message said] Tidal surge with flood waters up to 20 feet deep is expected in these areas within the hour, or within the quarter hour. That’s more specific.”

Others expressed interest in knowing the current extent of damage in areas already affected, and the potential for future damage. For example, one person stated: “I would like to know what kind of damage has been done thus far. Like, are we talking, like, mass casualties or are we talking some trees down?”

The lack of specificity about the predicted location of hazard impact was a primary concern for many participants. Several stated that they were extremely frustrated by the use of county names in the warning message rather than cities, towns, or landmarks that could be more easily identified by people who were unfamiliar with the area.

For instance, one person said: “I mean, where it was sighted—8 miles north of Eureka or 20 miles south of Eureka, because Eureka, Podunk county doesn’t mean anything if you’re out there on vacation. Where is it?”

Message understanding was also affected by a perceived lack of clarity about the ways that content was stated. For instance, the message stated that “damage has been reported,” but several participants questioned how the tsunami could continue to cause damage, asking how a threat could continue for an extended amount of time. This was echoed by others who said the statement “don’t be fooled, tsunami waves can seem to stop for long periods” did not clearly indicate what a “long period” is, nor what to expect at future points in time.

Language that conveyed certainty about the hazard impact and recommended protective actions also affected individual understanding. For instance, participants indicated that when they read that they were “advised” to stay off the beach, they interpreted the situation as “less risky.” One participant stated, “It sounds optional, rather than ordered. Doesn’t create a sense of urgency to get off the beach.” Comparatively, participants responded that “ordered” was a much stronger and less ambiguous term; the use of the word advised “almost sounds kind of casual or like you’re advised, like eh, but it’s up to you. I mean, if you want people off the beach say people are ordered to stay off the beach instead of advised.”

b. RQ2: Belief in the tsunami message

Focus group participants consistently believed that the message was intended to relay information about an imminent threat, by a credible source, and that the recommended actions, should they be taken, would lead them to safety. When one participant pointed out misspellings in the text, for instance, others suggested that this demonstrated a sense of urgency on behalf of the message sender, indicating that they needed to act quickly. Belief in the message, regardless of understanding, compelled participants to state that they intended to leave the area and search for more information, such as through an online source, tuning to local radio, or asking locals. However, throughout all four focus groups, belief in the message was also intricately tied to personalization of the message—that is, message receivers have to determine that the message was meant for themselves to truly assess whether or not they *needed* to pay attention or take action. We discuss this next.

c. RQ3: Personalization of the tsunami message

Message personalization was most frequently linked to the recipient’s ability to physically locate themselves

in proximity to the tsunami threat. Impact locations were identified in the message at the county level, such as Del Norte, Humboldt, and Mendocino counties, rather than cities, towns, or landmarks such as geographical formations or landmarks. Focus group participants discussed how this approach was not specific enough for them to make determinations about their area of risk.

In one focus group, several participants discussed the physical and affective response they had in response to this lack of knowledge. One person stated: “I have anxiety not having the information about where I am,” and another said, “my anxiety goes up because the message has told me that something has progressed, but I have no reference point,” and still a third said “I’m freaking out. All this time and I still don’t know where the hell I’m at.” Importantly, they did not express anxiety resulting from concerns about what to do to protect themselves from the hazard impact, but the lack of specific geographical information in the message that could aid them in determining if they were actually at risk. While anxiety was relayed as a negative effect resulting from a lack of knowledge, it did not appear to inhibit individuals from taking action. Instead, anxiety compelled many who stated that they planned to take action, either by leaving the area or looking for additional information.

d. RQ4: Risk information processing and sense making

As focus group participants discussed message contents and message style in relation to their message interpretation, they also identified gaps in their knowledge about tsunamis and described how they were closing those gaps to make sense of the threat, its impact, and its potential consequences. While the focus group moderator did not specifically ask participants how they were processing the message content, they referenced different types of experiences to evaluate message content. In particular, they recalled past vicarious experience obtained through media accounts, and personal or vicarious experience with hazards they think are similar in some relevant ways. We discuss these next.

1) MEDIA ACCOUNTS

Many participants indicated having read about, heard about, or observed news stories about recent events, such as the 2013 tsunami in Tohoku, Japan, or the 2004 tsunami in Aceh, Indonesia. This provided a basic familiarity with the hazard, in terms of its potential for destruction and the need to take quick action to avoid the threat. However, the scale of those large events was utilized as a point of comparison to minimize the threat

posed by a 2–4-foot wave. One participant stated, “Well, the phrase ‘damaging waves’ brings back flashbacks to the news with walls of water. But then you go, oh just 2 to 4 foot, that’s not so bad. Calm down.”

Another agreed and said, “I’m thinking 20–30 foot waves. 3 foot waves to me ain’t nothing. I’m thinking, ok, you move in but you don’t get on a plane back to Kentucky. I’m thinking 3 foot is enough to maybe damage door fronts, but it ain’t gonna reach into the city.”

2) PERSONAL EXPERIENCE: WAVES

Several participants described their experiences with 3–4 foot waves at a beach as their point of reference, resulting in minimization of the threat. For instance, one person expressed disbelief that damage could occur as a result of this kind of wave activity stating: “a 3 foot wave is taking out all of the docks? It’s just impossible to me.” Another said “You play in the waves and a damaging wave could just be eroding the shore, I mean, especially a 3 foot wave. Even a 6 foot wave doesn’t seem like that’s a big deal to me at all.” Another described their professional experience as a lifeguard as a reference point saying: “And I guess what I’m thinking too is I was a lifeguard at a waterpark and we had three foot waves in our waterpark. Yeah, they beat you up, but they, it ain’t a tsunami. So I guess that’s why I think a 3 foot wave is nothing.”

3) PERSONAL EXPERIENCE: OTHER HAZARDS

Although none of the participants had personal experience with tsunamis, most described having experienced, and having received warnings, for other hazards, especially tornados. They noted the consistency of language, such as watch, warning, and advisory, between the two hazards, indicating that these terms were unclear and did not relay information about what they should do in response to the threat. However, many also described the inconsistent use of the term “emergency,” recently implemented by the National Weather Service for severe tornadic events (Peralta 2013), and suggested that there is a growing expectation that if a tsunami is actively in process, if it has been sighted, it too should be called a tsunami emergency.

5. Discussion

The findings reported here reinforce three primary insights about message interpretation and risk information processing and sense making. First, warning messages must be designed with the end users in mind—including both those who are familiar and unfamiliar with the hazard threat. Prior research has demonstrated the necessity of clear and specific language that describes the

hazard, its impact and consequences, and the actions that individuals should take to protect themselves (Mileti and Sorensen 1990). Our findings on tsunami messages reinforce these conclusions. While respondents consistently reported that they would take action in response to the message, the infrequency of tsunamis means that they will likely be unfamiliar, even to coastal populations (Perry 2007; Lindell et al. 2015). However, as demonstrated by the sense making activities of our focus group participants, even people with limited familiarity make inferences about tsunamis based upon their vicarious experience obtained through the media and by personal or vicarious experience with hazards that they find salient. Therefore, providing very specific and clear details about the threat, its impact, and protective actions will be vitally important for individuals who are at high risk, especially in the absence of environmental cues or appropriate mental models (Lindell et al. 2015). Because more recent tsunamis have been dramatic and have resulted in devastating destruction, there is a need to relay information about the destruction that can be caused by even “small” tsunamis.

Second, the ability of a message receiver to determine their location and the potential impact to themselves and their surroundings is important not only for increasing their intent to take protective action, but also to also reduce their anxiety. This is not limited to those who are unfamiliar with an area; recent research has demonstrated that even local residents had difficulty correctly identifying the risk areas in which their homes were located when viewing a map (Zhang et al. 2004; Arlikatti et al. 2006). In most cases, ambiguous information will lead to information search; here we find that ambiguous information also results in a negative affective response associated not with the hazard threat itself, but with the lack of specificity relayed in the message content. Focus group participants suggested that their anxiety levels might have been reduced had they been given additional information about the hazard location and its location of impact using cities and towns or geographical markers that are easily found on maps. In the absence of additional clarifying information, anxiety appears to positively motivate individuals to search for additional information or to take protective action.

Third, message sense making for an unfamiliar hazard is multifaceted and includes both an understanding of the hazard itself, as well as the terminology used to specify the risk and its severity. This is complicated by the increasing diversity of terms being adopted by the National Weather Service to convey severity of tornadoes (i.e., “tornado emergency”), the use of color-coded risk charts [such as those by the NOAA Storm Prediction Center (NOAA Storm Prediction Center 2015)],

and the creation of new risk indices (such as TOR: CON, a tornado condition index, developed by The Weather Channel).

Consistent with other researchers (Lazrus et al. 2012) we found that “prior hazard experience” is not limited to prior experience with the hazard in effect. Instead, the concept of “experience” includes personal experience of the current warned threat, as well as personal experience of “similar” events, such as other activities and events that appear to mimic the present risk, recalled experience of warnings for familiar hazards, and vicarious experiences from recent media accounts. Importantly, this cross-hazard experience may serve as a primary strategy for interpreting risk information and has the potential to affect decision making processes for protective action taking.

6. Recommendations and conclusions

Here we have presented what may be the first published analysis of public responses to tsunami warning messages, taking into account message content and style factors as they affect sociopsychological activities of message interpretation. We have also investigated the sense making processes at work as individuals recall media accounts and personal and vicarious experiences to make sense of the message and its contents. These sense making activities may help to close gaps and empower people to cope (Lazrus et al. 2012), but they may also lead people to inaccurate understandings of the threat and strategies to protect themselves.

It is unsurprising that landlocked individuals, such as focus group participants from Lexington, Kentucky, would not be familiar with coastal threats. However, their recall of recent large-scale events and sensationalized Hollywood versions of environmental destruction led many to minimize the tsunami threat. As demonstrated following prior tsunami events, tsunami impact is not limited to locals (Lindell et al. 2015). Visitors, vacationers, and other travelers may also be among those who receive a tsunami warning. To increase understanding of the potential threat, additional information must be provided that clearly articulates the level of severity, and potential for injury or death, and property damage or destruction.

Importantly, this initial research was conducted with focus group participants who were high school graduates and above. Therefore the findings presented here might not generalize to a population with different demographic characteristics and future research should take this into account. Furthermore, this research included only a single warning message from a single source; a National Weather Service (NWS) message. In an

actual event people will receive information from multiple sources, including television and radio, neither of which is likely to utilize an NWS warning word for word. However, it does lend insights to the interpretations and sense making gaps that people who are unfamiliar with tsunamis might have. Future research should be conducted with a more broadly representative sample of message receivers to investigate message interpretation and behavioral intent comparing an original message and one that has been revised based upon focus group feedback. Future research should also investigate information processing and sense making when there are multiple message channels and sources. This initial study also lends support for additional research on hazard literacy alongside public education programs, that is, assessing the mental models of how tsunamis “work” in order to provide clear and compelling hazard warnings. And finally, it serves as a justification for future attempts to standardize language and terminology across hazards and their associated warning products. As warning language evolves for one hazard, such as tornado, public expectations may also shift, resulting in misunderstandings and inaction. The proliferation of new strategies to persuade people to take action in response to imminent threat warnings must consider the broader warning ecology that extends beyond the single hazard.

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