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# THE IDEA MODEL: DESIGNING EARTHQUAKE EARLY WARNING MESSAGES USING INSTRUCTIONAL RISK COMMUNICATION

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DISSERTATION

A dissertation submitted in partial fulfillment of the
requirements for the degree of Doctor of Philosophy
in the College of Communication and Information
at the University of Kentucky

By

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Lexington, Kentucky

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ABSTRACT OF DISSERTATION

# THE IDEA MODEL: DESIGNING EARTHQUAKE EARLY WARNING MESSAGES USING INSTRUCTIONAL RISK COMMUNICATION

The goal of risk communication is to inform people about the risks they face and to encourage them to take appropriate action in response to that threat. To achieve this goal, risk communication scholars continuously examine the messages surrounding crises and disasters, and engage in message-testing to evaluate theory-driven message designs. Recent communication scholarship recommends that messages should including instructing information (Coombs, 2012), and should take into consideration established pedagogy based on instructional communication research (Sellnow & Sellnow, 2010). This dissertation continues to build on research which applies instructional communication scholarship to risk communication messaging. Using message-testing, this dissertation examined the utility of the IDEA model a message design for earthquake early warnings.

KEYWORDS: Risk communication, instructional communication, IDEA model, sensemaking, warnings.

Nigel Haarstad

April 19, 2016

Date

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LIST OF TABLES

# Chapter 1: Introduction

During a natural disaster, warning messages issued to the public play an important role in minimizing harm to human life and property. These risk and crisis messages take many forms depending on the situation and the agency tasked with communicating those warnings, among a myriad of other factors. Residents of the United States receive numerous risk messages throughout the year. For example, the National Weather Service issued 18,308 public warnings for tornadoes and severe thunderstorms alone during 2014. (IEM, n.d.). As communication technologies continue to rapidly innovate, it has become easier to deliver warning messages to the public during crises, and information about these risks are becoming much more accessible (Veil, Buehner, & Palenchar, 2011).

## Earthquake Early Warning

One such innovation is a new earthquake early warning system proposed for the west coast of the United States. Earthquake early warning is not the same as earthquake prediction. The focus of a new earthquake warning project in development by the USGS is not to predict when and where an earthquake will occur. In fact, earthquake prediction is something that most seismologists agree will not be possible in the foreseeable future (Allen, 2008, October). Instead, the focus of existing and planned earthquake early warning systems is to rapidly detect earthquakes the moment they begin, assess the location, determine the amount of shaking and send warnings to the population likely to be impacted.

Following the lead of earthquake early warning systems developed in Japan, Taiwan, Mexico, Turkey, and Romania, the USGS, Caltech, and other partners have begun developing and beta-testing a system that monitors seismic activity and sends an

alert message warning of any impending shaking (Neith, 2013). The current prototype, known as ShakeAlert, utilizes a network of seismometers distributed throughout California that measure ground motion. When an earthquake occurs, seismic "waves" radiate away from the epicenter, "like the waves on a pond after you've thrown a rock into the water" (Neith, 2013, p. 12). When these waves reach nearby seismometers, the signals are sent to computers to analyze the waves and predict where shaking will occur, the strength of that shaking, and when the wave will impact a specific location. Once these calculations are made, an automated warning can be sent out to users before those seismic waves (and the associated shaking) arrive. Studies of earthquake early warning methods in California have shown that the warning time would range from a few seconds to a few tens of seconds, depending on the distance to the epicenter of the earthquake (Burkett, Given, & Jones, 2014).

The ShakeAlert prototype incorporates a dense amount of information in the warning message. Users currently see a map, with an icon representing the earthquake epicenter, an icon representing the user's current location, a yellow circle for the location of the P-wave, and a red circle for the S-wave associated with the earthquake. In addition, the warning message displays a countdown timer, the estimated magnitude of the earthquake, and the expected intensity for the user's location using the modified Mercalli intensity scale. The expected intensity is displayed using Roman numerals, and also in written form at the top of the screen (e.g., "moderate shaking expected"). This is accompanied by a legend explaining the intensity scale, as well as a handful of buttons relating to various program settings (Burkett, Given, & Jones, 2014). All of this

information is displayed on one screen at the same time, presenting the user with a high volume of technical information in a short amount of time.

The current ShakeAlert prototype delivers a dense amount of technical information to users, and is intended to be understood and acted upon in a very short amount of time. However, just because an individual receives a warning message, it is not guaranteed that they fully understand the message or act on it as the sender intends. In an effort to increase the effectiveness of these warnings, this study will build on instructional and risk communication research to design and test earthquake early warning messages.

**Designing an Effective Message**

Delivering a warning message does not guarantee its effectiveness. During crises, communicators must overcome several serious constraints. For example, Mileti et al. (1990) point out that there are a variety of both sender and receiver factors which influence the "probability" that a warning message "will be correctly understood, believed, personalized, and acted upon" (pp. 5-8). Petty and Wegener (1998) found that messages are unlikely to motivate individuals to take action unless those individuals perceive a direct threat to their personal well-being. Mileti et al. (2000) argue that the most effective warning messages contain specific instructions for protective action. Finally, Albarracin and Vargas (2010) explain that individuals must actually comprehend the content of that message in order to act on it. These findings represent a portion of the sprawling and complex interdisciplinary bodies of research surrounding warning messages.

Sellnow & Sellnow developed the IDEA model as a comprehensive guide to designing risk messages. This model incorporates instructional communication and risk communication theory to guide the development of effective warning messages, using a receiver-based approach (Sellnow et al., 2014). To date, the model has been applied primarily to food safety contexts **(**e.g., Littlefield et al., 2014; Sellnow & Sellnow, 2013; Sellnow et al., 2014, Wilson, 2014). This study will apply the IDEA model to earthquake early warning messages to better understand the extent to which the IDEA model can operate effectively in a short time frame of 10 seconds or less and beyond the scope of food safety messaging.

**Significance**

Earthquakes pose a great risk for many in the United States – 75 million Americans live in areas of significant seismic risk across 39 states. Most of our Nation's earthquake risk is concentrated on the West Coast of the United States. The Federal Emergency Management Agency estimates the average annual loss from earthquakes, nationwide to be about $5.3 billion, with $4.1 billion stemming from losses in California, Washington, and Oregon, and $3.5 billion from California alone (Burkett, Given, & Jones, 2014). Moreover, the United States Geological Survey (USGS) estimates that California has a 99.7 percent chance of a magnitude 6.7 or larger earthquake by 2038. They also predict that the Pacific Northwest has a 10 percent chance of a magnitude 8 to 9 earthquake on the Cascadia subduction zone which runs from California north into Canada during that same time period (Allen, 2008, October). Timely warnings have the potential to save numerous lives in the event of a strong earthquake, giving people time to

take cover under sturdy furniture to avoid falling objects, a common source of injury during earthquakes (Birmingham, 2011, March 18).

***Existing Warning Systems*** . Earthquake early warning systems already in use elsewhere have shown positive results. Japan's earthquake early warning system, operated by the Japanese Meteorological Agency, includes two alert types: Advanced Notice Forecasts and Earthquake Alert Warnings (Hoshiba et al., 2011). Advanced Notice Forecasts are only issued to expert users when a seismograph predicts an earthquake of magnitidue 3.5 or greater (Matsumura, 2011). These alerts are less accurate and are usually updated five to ten times in a 60-second period as more seismic data becomes available (Kamigaichi et al., 2009). The advanced users who receive these "forecasts" include railway companies, construction sites, schools, hospitals, and other locations where extra time is needed to shut down operation prior to an earthquake (Yamasaki, 2012). During the first three years of operation, there were 30 false positives out of a total of 1,713 Advanced Notice Forecasts issued, representing a 1.75% failure rate (Yamasaki, 2012). The users who receive these alerts get special training from the Japanese Meteorological Agency to make sure they can properly interpret and act on the warning messages (Birmingham, 2011).

Japan's Earthquake Alert Warnings, intended for the general public, more closely resemble the alert messages examined in this dissertation. These warnings require detection by at least two stations (unlike advanced notice forecasts) in order to reduce false positives and to provide more accurate warnings. The first warning only includes the names of the forecast regions where the intensity of the shaking is predicted to reach 3 or more on the Mercalli scale. As more information is fed into the system, these

warnings are updated with the location of the earthquake's epicenter, the estimated magnitude, and the names of all regions with a predicted seismic intensity of 4 or greater (Matsamura, 2011).

Japan employs a wide variety of communication channels to broadcast these public-facing warnings. The Japanese Meteorological Agency uses a system of outdoor loudspeakers, television broadcasts, radio networks, as well as alerts via text-messaging and smartphone apps (Yamasaki, 2012). The messages are use text as well as audio in five languages, including Japanese, English, Mandarin, Korean, and Portuguese (JMA, n.d.). While information is available to assess the timeliness and accuracy of these warning messages, very little evidence is available (beyond anecdotal accounts) regarding the lifesaving effect of these public-facing earthquake warnings (Yamasaki, 2012).

Mexico launched its own earthquake early warning system in 1985, after a magnitude 8.0 earthquake killed 9,500 people (Lin & Becerra, 2014). Like Japan, the warning message is distributed through a variety of channels, including television and outdoor sirens. However, warnings are not yet distributed widely via cellphone, limiting the message's reach (Lin & Becerra, 2014). More recently, more users have signed up for app-based alerts on their smartphone. As of 2013, the leading seismic alert app, SkyAlert, had 3 million users (Thomet, 2015, September 19). Once again, it is difficult to quantify how many lives, if any, have been saved by these warnings, as most reports and studies focus on the technical performance of the warning system (Wood, 2014, April 30).

Taiwan has a similar system, which focuses on alerting schools, but also sends alerts to the public via broadcast media (Kuo, 2013, September 8). While the

technological details are largely similar, Taiwan's system affords less warning time than the Japanese or Mexican alert systems, because Taiwan is geographically closer to the fault line where earthquakes occur. Another notable difference is in education – the Taiwanese government focuses on educating schoolchildren about earthquake safety so that they will pass the information along to their parents and the rest of the household. Students are taught to run outside if they are on the first floor, and students on higher floors are taught to protect their heads with their backpacks (Kuo, 2013, September 8).

***Limitations of Current Systems*.** Overall, these systems share the same limitations. First, they offer a limited amount of lead-time – many users will receive no more than 10 seconds of warning before the shaking begins. Second, there is the possibility for false-positives to reduce the public's confidence in the warnings or, at least, cause confusion. Third, the information presented is highly technical in nature, and can be difficult to interpret in a useful manner. Finally, relevant to this study, is the striking lack of information regarding the effectiveness of these earthquake warning messages. Most of the studies outlined above focused on the warning systems themselves, and only provided anecdotal or passing analysis of the public's response to those warnings. Therefore, theory-driven message testing of earthquake early warning messages is warranted.

## Project Overview

This dissertation will evaluate the effectiveness of earthquake early warning messages designed using the IDEA model. In addition, this study will explore the ability of message receivers to make sense of the message in a manner consistent with USGS recommendations for protective action during an earthquake. The analysis will compare

four message designs simulating an earthquake early warning message which would appear on a smartphone. Each of these conditions is designed using the IDEA model (i.e., Internalization, Distribution, Explanation, and Action), but each condition has different characteristics, outlined in chapter 3. The study aims to use a theory-driven approach to designing earthquake warning messages, while also serving as a platform to further instructional risk communication scholarship.

**Overview of Chapters**

This dissertation is organized into six chapters. Chapter One provided an introduction to the problem and a rational for further study of earthquake early warning and instructional risk communication. Chapter Two provides review of relevant literature pertaining to sensemaking, risk communication, and instructional communication leading to a series of hypotheses and a research question. Chapter Three describes the methods and tools used for data collection and analysis. The results will be provided in Chapter Four. Finally Chapter Five will provide a discussion of the results, limitations, future research, and the conclusion.

## Chapter 2: Literature Review

In risk and crisis situations, such as an earthquake or other natural hazard, individuals attempt to protect themselves from harm. Effective communication about those hazards and how to protect oneself from harm is essential to mitigate the impacts of those risks (Sellnow, Ulmer, Seeger, & Littlefield, 2009). The United States Geological Survey provides the public with a variety of information relating to long-term earthquake risks. However, real-time earthquake early warnings will need to be carefully crafted in order to be effective in the short amount of available time prior to the arrival of shaking. Therefore, it is important to review existing research on risk communication before setting out to design these warnings. Specifically, these warning messages will need to consider how people make sense of messages during time-bound crises, and how instructional communication can improve outcomes in these cases. This chapter will review existing research on these topics to propose various research questions and hypotheses intended to increase our understanding of effective instructional messages in risk communication.

### Risk Communication

Risk communication can be thought of as "an interactive process of exchange of information and opinion among individuals, groups, and institutions" (National Research Council, 1983, p. 21). A message-centered approach to risk communication argues that this action would ideally "build trust through participation" in the process of making decisions about risks (Kasperson, Kasperson, Pidgeon, & Slovic, 2010, p.333). Risk communication scholarship finds that, in many cases, an interactive dialogue contributes to "the quality of risk decisions through better communication" (Palenchar & Heath,

2002, p. 129). Many of the risks we face occur over a large enough time period to allow for dialogic communication among stakeholders. When there is an outbreak of foodborne illness or a hurricane a few days away from landfall, the public has time to hear the message, confirm with other sources, evaluate their risk, and ask questions of experts.

Not all risks manifest so slowly, however, leaving little to no time for the ideal dialogic process espoused by risk communication scholars. When the level of risk suddenly escalates, communication must shift from a dialogic approach to a focus on instructional messages focused on guiding self-protection (Mileti & Peek, 2000; Sellnow & Sellnow, 2010). When a risk manifests rapidly, "instructing information uses strategies that seek to tell stakeholders what to do to protect themselves from the crisis" (Coombs, 2009, p. 105). Reynolds and Seeger (2005) argue that messages must focus on "personal response activities" (p. 52) as the perception of immediate risk heightens. This assertion is supported by Seeger (2006) explaining that "specific harm-reducing actions to those affected by the crisis" is a best practice of risk and crisis communication (p. 242). Before any of this happens, however, individuals must recognize that they face a particular risk, and must be able to use information available to them to make a decision. This fundamental process becomes even more important when the time from earthquake warning to necessary response is so tightly constrained. Therefore, we must understand how people make sense of these risks and how that impacts how they use their time in the decision-making process.

**Sensemaking**

During a natural disaster or other crisis event, individuals will, of course, try to protect themselves from harm. During an earthquake speciifically, the USGS and other

agencies recommend that individuals "drop, cover, and hold on." To some residents who are accustomed to earthquakes, this may be common sense. Still, for those who are unaccustomed to earthquakes, a brief moment of hesitation or lack of clarity from the message can completely negate the efficacy of that message, especially considering the very short time period in which individuals have to take protective action. Thus, it becomes important to understand how individuals make sense of information during the crisis in order to create an effective message.

Weick (1979) focused his attention on organizational crises when he first proposed sense making, focusing on the uncertainty in the way individuals find meaning during the crisis. Although the theory was conceptualized as an organizational communication theory, it has increasingly been used to understand phenomena outside of that limited context, including at the community level (Coffelt, Smith, Sollitto, & Payne, 2011). By examining the constructs underpinning Weick's theory, the case for its application to earthquake early warning becomes clear.

The initial construction sensemaking includes four tenants: 1) ecological change, 2) enactment, 3) selection, and 4) retention (Weick, 1979). Individuals experience the sensemaking process during a crisis in order to construct, filter, frame, and create meaning from their surroundings and information they encounter (Frost & Morgan, 1983; Morgan, Frost, & Pondy, 1983). Individuals and organizations make decisions through this process in order to decide their best course of action.

**Properties of Sensemaking**

As Weick continued to work with the theory of sensemaking, he outlined seven properties, explaining sensemaking as a process that is: 1) grounded in identity

construction, 2) retrospective, 3) enctive of sensible environments, 4) social, 5) ongoing, 6) focused on and by extracted cues, and 7) driven by plausibility rather than accuracy (Weick, 1995, p. 17). These properties guide to sensemaking process. In order to apply sensemaking to risk communication in general and earthquake early warning specifically, it is necessary to more clearly understand the major components of this theory.

***Identity construction***. Weick argues through this theory that a person's identity forms as that individual reacts to their environment. "The sensemaker is himself or herself an ongoing puzzle undergoing continual redefinition, coincident with presenting some self to others and trying to decide which self is appropriate" (Weick, 1995, p.20). This is done in response to what is occurring in that individual's environment. One of the most recognizable aspects of this theory comes from a question the sensemaker must ask when constructing his or her identity, "How can I know what I know until I see what I say?" (Weick, 1995, p. 18). This question places identity construction at the center of the enactment process. Through this line of reasoning, the premise that the self, and construction of one's identity is a dynamic process of self enhancement, self-efficacy, and self-consistency – identity construction is, therefore, different for each person (Erez & Earley, 1993).

The above statement seems counter to Weick's (1995) contention that "no individual ever acts like a single sense maker" (p.18). However, he goes on to argue that the identity construction process is social and dependent on how the individual learns to make sense of himself or herself. The need to experience coherence and continuity drives identity construction, which involves a "complex mixture of proaction and reaction" (Weick, 1995, p. 23). In an earthquake warning scenario, this means that each individual

will be driven to respond to the warning message in a way that develops continuity between past behavior and beliefs and the course of action on which he or she decides.

***Retrospective***. Retrospection allows for the creation of meaning because "people can know what they are doing only after they have done it" (Weick, 1995, p. 24). Individuals can only attend to what exists, that is, what has already occurred. Weick suggests that the sensemaking process begins shortly after the actual act. While hindsight may make an event or act more clear, retrospection cannot completely destroy the actual memory of the event. In sensemaking, meaning emerges through enactment with and attention to the environment. Through this process, the problem is equivocation and confusion, not uncertainty or ignorance.

While sensemaking focuses on previous experiences, Weick (1979) suggest that sensemaking can focus on the future through a "future perfect" hypothetical situation (p. 198). The "picture-perfect" situation allows an individual to assume the action that he or she would take, thus allowing for retrospective sense based on a hypothetical future decision. For many natives of the Southern California area who are accustomed to the threat of earthquakes, it may not be necessary to make sense using a "future perfect" situation. However, for visitors or recent transplants to the area, or for unique scenarios such as facing earthquake well in a high-rise building for the first time, this future perfect scenario will likely play a role in sensemaking. Engagement with and attention to a warning message as well as public safety campaigns prior to an earthquake may aid those who lack past personal experience to make sense of the crisis and create a "future perfect" scenario from which they can base a decision.

***Enactment***. Weick (1979, 1995) contends that no two individuals perceive the same environment. Through the process of enactment, individuals construct their own environment. Therefore, it follows that an individual is part of the environment that he or she creates, and act within that constructed environment. Thus, they create materials from which sensemaking occurs as well as the constraints which limit their ability to make sense of their environment (Weick, 1995). However, these constructed environments may be too large, confusing, and complex four an individual to attend to all elements during the decision-making process (Seeger, Sellnow, & Ulmer, 2003). This is especially true during the earthquake early warning scenario, weather may be only tens of seconds to make sense of and response to a warning. Constructing messages which will prompt individuals to connect with most appropriate information allows for the selection of beneficial information and interpretations. Essentially, a properly constructed message shoot aid in the selection of protective information end facilitates the creation of an environment for that individual which fosters positive sensemaking.

***Social process***. Weick (1995) described sensemaking as a social process through which the negotiation of meaning is possible. He explains, "often one's conduct is contingent on the conduct of others, whether those others are imagined or physically present" (Weick, 1995, p. 39). The interaction and influence of others will impact an individual's interpretation of any given situation. Influences on sensemaking do not arise solely from physical presence, but also through enactment of the environment through what is socially constructed. Weick's notion draws on Blumer's (1969) "symbolic other." The symbolic other allows an individual to process the event or action, decide what has

happened, and decide what action he or she should take based on what the symbolic other would do.

During an earthquake warning, there is very little time for an individual to engage in the social construction and enactment of their environment. However, in situations where risk and crisis messages are received and interpreted over a long period of time, the social nature of sensemaking poses a threat to effective communication. Risk and crisis communicators attempt to disseminate uniform messages to promote collective sensemaking among the public surrounding a crisis. However, sensemaking would indicate that individuals and groups who receive the message have the potential to make sense of the message in different ways. This effect may be compounded when individuals receive a variety of messages from multiple sources. As Weick (1995) states, "To understand sensemaking is to pay more attention to sufficient cues for coordination such as a generalized other, prototypes, stereotypes, and roles" (p.42) including the convergence of multiple sources or multiple messages. During an earthquake warning, there is little to no time for individuals to seek out and interpret multiple messages. Nonetheless, a well-constructed warning message can shape the construction of the symbolic other in a way which promotes positive sensemaking and a beneficial outcome.

***Ongoing***. Sensemaking is an ongoing process which never starts nor stops (Weick, 1995). Instead, Weick argues that we make sense of our reality when we "chop moments out of continuous flows and extract cues from those moments." (p.43) Going further, Weick argues that "people are always in the middle of things, which become things only when those same people focus on the past from some point beyond it" (p.43). The ongoing nature of sensemaking means that messages should benefit from being

accessible for long periods of time. Again, earthquake warning messages do not have that luxury, potentially limiting the ability for that message to promote positive sensemaking. This raises the stakes for the warning message to be designed in such a way as to be understandable and persuasive in a much shorter amount of time than normal.

***Extracted cues***. Extracted cues refer to key elements of ones environment which the individual notices and uses to make decisions and make sense of their situation. Weick argues that sensemaking is a rapid process where "we are more likely to see products than process" (Weick, 1995, p. 49). Starbuck and Milliken (1988) distinguished between noticing and sensemaking, suggesting that noticing includes classification, comparing, and filtering, while sensemaking refers to the active interpretation used to determine the meaning of extracted cues. Crisis messages should be designed to encourage receivers to notice key elements of the warning message and simplify the sensemaking process. The short time frame provided for an earthquake warning, as well as the small surface area of the smartphone screens on which the warning will appear, means that these messages will necessarily be designed to focus on key elements of the message, aiding in sensemaking from extracted cues.

***Plausibility***. Finally, Weick argues that "The strength of sensemaking as a perspective derives from the fact that it does not rely on accuracy and its model is not object perception" (Weick, 1995, p.57). In this statement, Weick explains that individuals make sense of their environment by looking for cues which seem plausible when incorporated into their ongoing interpretation of reality. Especially when time is a limiting factor, individuals are more apt to make decisions based on plausibility rather than accuracy. Instead, plausibility entails "pragmatics, coherence, reasonableness,

creation, invention, and instrumentality" (Weick, 1995, p.57). The desire for plausibility over accuracy means that message creators must strive to make their messages clearly plausible with their target audience's experiences. When applied to earthquake warnings, this may indicate that message creators should worry less about the highly technical explanations of intensity scales, magnitudes, amplitudes, p-waves and s-waves, and instead focus on building the plausibility of their message. Previous research outlines how this might be achieved. Freberg (2012), Starbird and Palen (2010), and others found that credibility can be established through identifying a respected source (such as the USGS) or through the content of the message (through source attribution and clarity) in order to help establish the plausibility of the message's content.

**Process of Sensemaking**

In addition to the seven properties outlined above, Weick (1995) describes sensemaking as comprised of four distinct tenets: ecological change, enactment, selection, and retention. It is important to understand these fundamental tenets prior to applying sensemaking to the analysis the earthquake warning messages.

***Ecological Change***. The first phase of sensemaking is a result of the acute phase of the crisis. Individuals actively scan the environment and observe changes, either first hand or through mediated channels such as television or social media. Ecological change describes the violation of an expectation, and the creation of equivocality and uncertainty (Weick, 1979). This change disrupts an individual's daily functions in some way and, in doing so, alters expectations and behaviors. Awareness is a necessary element of ecological change. If an individual is unaware of the change or its impact on their expectations or behaviors, a violation has not occurred. Weick (1993, 1995, 2009) defines

this breach in expectation as a cosmology episode. Weick (1993) explains that a cosmology episode happens when "people suddenly and deeply feel that the universe is no longer a rational, orderly system" (p. 633). Ecological change does not necessarily need to occur on such a total scale, however, to induce sensemaking. Weick (2009) asserts that "we expect to find efforts at sensemaking whenever the current state of the world is perceived to be different than the expected state of the world" (p. 140).

A change in the environment promotes two types of opportunites for sensemaking: changes that promote ambiguity and changes that promote uncertainty. Weick (1995) suggests that there is a difference in the shock associated with ambiguity and uncertainty. Specifically, he argues that "[in] ambiguity, people engage in sensemaking because they are confused by too many interpretations, whereas in the case of uncertainty, they do so because they are ignorant of any interpretation" (p. 91). An effective earthquake warning, therefore, will provide recipients with an interpretation of the situation which allows them to move beyond uncertainty. However, depending on how clearly the information is described (including location, level of intensity, protective actions), there is an opportunity to inadvertently introduce ambiguity in that message.

***Enactment***. The enactment tenet of sensemaking describes the argument that cognition occurs during action, because action focuses cognition. Weick (1988) demonstrates how action takes place before cognition, explaining that "the sensemaking sequence implied in the phrase, 'How can I know what I think until I see what I say?' involves the action of talking, which lays down traces that are examined, so that cognitions can be inferred" (Weick, 1988, p. 307). It is through enactment with one's environment that materials are collected for making sense of that environment.

Enactment is the only process in the sensemaking process where the individual engages with their external environment. All subsequent sensemaking is based on the materials and understandings already collected (Smirchich & Stubbart, 1985; Weick, 1979). As crisis represents a change or departure from expectations, individuals cannot begin to understand the crisis without taking some initial action (Seeger, Sellnow, & Ulmer, 2003). Enactment is the initial action which constructs the reality of the situation from that point forward until the next instance of enactment. Weick (1979) explains, "The product of enactment is not an accident, an afterthought, or a byproduct. Instead, it is an orderly, material, social construction that is subject to multiple interpretations" (p.130). Applied to an earthquake warning message, this means that providing individuals with an opportunity to engage with information increases the opportunities for enactment.

***Selection***. The products of the enactment process are interpreted during selection. In an attempt to reduce uncertainty, individuals develop plausible interpretations of the information they obtained through interacting with their environment. During the selection process, individuals determine the meaning of enacted information through their experiences and interests (Weick, 2001). However, as information passes into the selction process, meaning is established by the collective rather than the individual alone. This shift from individual to shared meaning suggests that different publics will attend to the products of enactment in different ways (Weick, 1979). Selection is the process through which individuals determine which elements of enactment are useful in reducing the equivocal environment left by the cosmology episode or violation of expectations. In the case of earthquake warning messages, the warning message itself may serve as the first exposure to the changing environment (one that does not shake to one that does) and also

as the enacted material through which the selection process begins. Thus, the warning message should not only warn of an impending earthquake, but provide suggestions for protective action as well.

***Retention***. Retention describes the use of previous interpretation in future episodes of sensemaking. Did the individual retain the interpretations gained during their last process of enactment and selection? Weick (1995) explains that retention is the "relatively straight forward storage of the products of selection" (p. 397) which result in an enacted environment based on the connected summary of previous instances of sensemaking. Sensemaking relies on retention to effectively provide feedback to the previously mentioned processes of sensemkaing. As Weick and colleagues explain, "when a plausible story is retained, it tends to become more substantial because it is related to past experience, connected to significant identities and used as a source of guidance for further action and interpretation" (Weick, Sutcliffe, & Obstfeld, 2005, p. 414). This indicates that a warning message will be most effective if it builds on previous interpretations of an individual's environment. One example of this may include using a familiar, respected official's voice to narrate the warning message in order to build on the established, retained sense of credibility perceived by members of the public.

**Applications of Sensemaking**

Weick asserts that sensemaking is neither positive nor negative, but rather a neutral process. However, the goal of a warning message and risk communication in general is to foster attitudes and actions which will persuade people to act to protect their safety. Thus, when we evaluate the sensemaking enacted by individuals when faced with

a warning message, it is appropriate to gauge whether it prompts them to take the actions prescribed in that message.

The history of sensemaking research reveals the theory's applicability to risk communication. Weick (1988; 2010) used sensemaking to understand risk communication surrounding the Bhopal Union Carbide chemical leak. Weick concluded that the social cues received by plant employees, coupled with the environmental cues that went overlooked, played a large role in the crisis. His study concludes that the influence of social cues surrounding the crisis shows the need to recognize the influence individuals have on communication, rather than analyzing the facts solely at the organizational level.

One of the more widely-known applications of sensemaking – the Mann Gulch wildfire – shows the value of understanding risk communication through sensemaking and instructional communication. The Mann Gulch fire was a wildfire in which 13 firefighters were killed (Weick, 1993). Due to a number of variables, the firefighters found themselves in danger and running for their lives from the advancing wildfire. When all of their normal tactics failed and the wildfire threatened to overtake them, the leader of the group lit a fire and instructed the other firefighters to jump into the ashes (a tactic now known as an escape fire). At this point, the second most senior firefighter exclaimed, "to hell with that, I'm getting out of here" (Maclean, 1992, p.95) and continued running away from the fire. The rest of the firefighters now had to make sense of the situation. Setting a fire and laying down in the ashes was not consistent with the other firefighters' understanding of how to escape from a fire, especially as they watched the other senior firefighter continue to flee. This discontinuity and the cues from the two

leaders challenged the crew's ability to make sense of the situation in a manner consistent with their best interests. Ultimately, the inability of the firefighters to make sense of the escape fire led to many of their deaths (Weick, 1993). Again, this underscores the importance of providing instructing information during risk and crisis communication. If the receiver does not make sense of the message in a beneficial way, the effectiveness of the warning message is lost.

Sensemaking was also used to shed insight into the risk communication surrounding the 1997 Red River Valley floods in North Dakota and Minnesota. Sellnow & Seeger (2001) argue that the inability of local officials to make sense of certain environmental cues impaired their ability to respond to the imminent flood. Instead, local officials seemed to select environmental cues which bolstered their opinion that there would not be catastrophic flooding: previous floods had not been catastrophic, the existing forecast called for flood waters to stay below the dikes, and initial measurements were in line with previous manageable floods (Sellnow & Seeger, 2001). The cosmology episode occurred when local leaders realized that the river gauges were not accurate and that flooding was much worse than they had realized. Local officials and, in turn, the public were harmed by their inability to make sense of the environmental cues which actually would have indicated the impending flood. In the context of the present study, the lesson learned is that the response was ineffective because a variety of people did not make sense of their environment accurately or in a way that helped them protect themselves, further pointing to the need for effective instructional risk messages.

This theory has also been used to evaluate sensemaking at the community level when Coffelt (2011) and colleagues used sensemaking to understand the community-

level response to a 2009 ice storm which struck Illinois and Kentucky. Forecasters and the public alike were caught off guard when two rounds of ice storms caused power outages and stalled travel across 91 counties (Coffelt et al., 2011). This study investigated how residents made sense of the storm, specifically focusing on enactment and selection during the ice storms. Because everyone was expecting a routine storm with only a small amount of ice accumulation, the public did not seek out nor encounter communication about how to prepare for an ice storm. Residents experienced a cosmology episode when their expectations were violated and they found themselves impacted by a major storm. Thus, Coffelt and colleagues suggest that it is necessary to elevate the perceived threat in order to gain the attention of those members of the public who are most at risk. If individuals do not perceive the risk as severe, they are unlikely to heed advice about protective action (Coffelt et al., 2011). Therefore, risk messages must contain an element of threat in order to promote positive sensemaking.

The studies outlined above regarding sensemaking mainly employed qualitative methods with a significant emphasis on organizational communication. Sensemaking research has expanded, however, to include quantitative methods and community-level settings (e.g., Coffelt et al., 2011). It is clear that sensemaking is a useful theory for understanding risk communication at multiple levels, and can be studied using a variety of approaches. This study will continue to expand the use of this theory by employing sensemaking as a means to understand the effectiveness of the IDEA model for instructional risk communication. Exploring how instructional communication contributes to better sensemaking during a crisis situation has the potential to reduce harm and improve message construction.

**Health Behavior Approaches to Behavior Change**

Risk communication is employed in order to change behaviors. Risk communicators want to motivate members of the public to take specific actions they otherwise would not take without some intervention (the message). In this way, existing theoretical approaches to health behavior often overlap both in content and purpose with risk communication literature. It is worth noting, then, the various approaches health communication and public health scholars have approached the study of behavior change in the context of health risks.

The overall purpose of risk communication is to inform people of the risks they face to enable and encourage them to make better choices in order to avoid hazards they face. DiClemente, Salazar, and Crosby (2013) explain that the overall purpose of health promotion theory is to reduce the level of risk behavior and lower levels of risk within a given population. Like communication scholarship, theories of public health span multiple levels. The Ecological Model (Bronfenbrenner, 1979) outlines the various levels of which health behaviors occur. Of course, theories may be designed to operate at particular levels of this model as well. DiClemente et al., (2013) explained that there are many health behavior theories for the proximal, or poor, level of this ecological model, while significantly fewer theories applied to the distal levels relating to community and society.

Social Cognitive Theory (SCT) is one behavioral theory used in public health which addresses multiple levels of ecological model. In general terms, the theory contends that one social environment, personal characteristics, and behavior interact and influence each other (Bandura, 2004). Five constructs within this theory include:

knowledge, perceived self-efficacy (which must be task specific), outcome expectations, goal formation, and socio-structural factors (Bandura, 1984, 2004; DiClemente et al., 2013).

Social cognitive theory resembles some of the tenants of the IDEA model, discussed in the next section. Both are grounded, in part, by learning theories in psychology. The IDEA model is based on Kolb's (1984) Learning cycles model, whereas, SCT Evolved from Bandura's (1984) Social Learning Theory. SCT focuses on the social process of observing behavior, modeling, reinforcement, and cognition (e.g., modeling observed TV violence); whereas learning cycle models historically tends to focus more on classroom instruction. Additionally, both approaches underscore the importance of self-efficacy and providing task specific actions.

Many theories of health behavior stressed the influence of one's environment. The Structural Model of Health Behavior (Cohen et al., 2000) emphasizes how environmental factors impact behavior. The accessibility of the behavior, the physical environment, social instruction policies, and media and cultural influences are key aspects of this theory. The Theory of Reasoned Action (Ajzen & Fishbein, 1980) concludes the police of the behaviors shape behavioral intent but social influences are equally important.

In many cases, the field of public health makes use of health education theories and research when crafting public health campaigns. This area of literature maintains some grounding in psychology, but places more attention on the goal of the message or communication. Health promotion and health mediation campaigns are often large-scale endeavors with high-impact goals (Salazar et al. 2013). Therefore, it is important to be able to reach effectively persuade a large number of people. To that end, health

communication research employs a number of models and theories to explain the role of communication and behavior change.

The Reception Yielding Model, based on McGuire's (1968) work, focuses on the role of persuasion messages in behavior change. This model outlines the process individuals must go through before acting on a persuasive message according to the theory. The steps in order are: presentation, attention, comprehension, yielding, retention, and behavior. Ultimately, the Reception Yielding Model has been refined to mathematical product of reception probability x yielding probability. The model takes a linear approach to the communication involved in health behavior change.

The Elaboration Likelihood Model (ELM; Petty & Cacioppo, 1986) addresses attitude change there's two routes: cognitive and emotional routes, which they call the central and peripheral routes. In the simplest terms, the peripheral route may be used to gain attention while the cognitive route is used to provide for lasting, tailored, and logic-based communication. This approach instructs the communicator to start by establishing an emotional appeal before moving on to more substantial, logic-based arguments.

Finally, the Extended Parallel Process Model, or EPPM (Witte, 1992) essentially combines a number of theories relating to messages. This theory focuses on an individual's perceived efficacy and the perceived threat, and how individuals respond to fear rousing messages. Ultimately, all of these theories may be categorized into two themes: theories of public health which emphasize environmental factors in psychology and behavior, and those from health communication which emphasize the message and psychology of persuasion. While none of these theories directly inform the present study, their evolution alongside risk communication, instructional communication, and the

sociology of disasters is noteworthy due to the striking overlap in findings between these areas, lending credibility to the approaches outlined below.

**Instructional Communication**

Instructional communication describes a body of research concerned with the role communication plays in the instructional process, regardless of the academic discipline or setting (Morreale et al., 2014). Like other areas of communication, its social-scientific inquiry may focus on message variables, sender/receiver characteristics, environmental or situational influences, and social or societal influences to the communication process. Instructional communication can, at times, overlap with related fields of study, such as communication education and communication pedagogy. A study about the impact of teachers' immediacy behaviors on student learning in a public speaking course could be categorized as communication education, communication pedagogy, but also as instructional communication (Morreale et al., 2014). The key difference is that instructional communication transcends contexts to include the role of communication in all types of learning and instruction, whether it takes place in the classroom or in some other public or private setting.

Communication Education, on the other hand, is focused specifically on education about communication concepts (Morreale & Pearson, 2008). Hunt, Wright, & Simonds (2014) provide, perhaps, a more clear definition, explaining that the purpose of communication education is to "Promote the development of students' communication competencies" (p. 121). As communication instructors are so fond of reminding students, the historical roots of communication education date to the study and teaching of rhetorical strategies in ancient Greece and, later, Rome (Mmreale et al., 2014). Over the

next 1,500 years, institutions of higher education and. religious institutions sustained the study of rhetoric because of its central role to the missions of both institutions (McLuhan, 2006). In recent years, communication education has found a role in higher education by demonstrating the central role communication skills play in other core learning outcomes in the university setting. For example, Simonds et al. (2012) outline how communication knowledge skills align with the LEAP program (Liberal Education for America's Promise), as well as related initiatives for quality improvement in higher education. Specifically, the "intellectual and practical skills" component of LEAP include written and oral communication, critical and creative thinking, inquiry and analysis, information literacy, teamwork, and problem solving, all of which are areas impacted by communication skills. The second LEAP outcome, "personal and social responsibility," includes civic knowledge and engagement, intercultural knowledge and competence, ethical reasoning and action, and foundational skills for lifelong learning. Simonds et al., (2012) outline in great detail how each of these areas are central to and justify the significance of communication education.

Communication pedagogy is distinct from both instructional communication and communication education. This area of study concerns itself with the pedagogy, theory, and best practices for teaching communication (Sprague, 1993; 2002). Book (1989) defines communication pedagogy as "the intersection of knowledge of the content of communication with the pedagogical strategies to most effectively bring about change in speech communication skill acquisition by students" (p. 315). While much research exists on this topic, Jennings (2010) points out that K-12 educators often lack formal training in communication education. Many instructors receive their training in English rather than

communication, creating a barrier to the implementation of communication pedagogy. At the university level, however, substantial lines of research include service-learning (Oster-Aaland, Sellnow, Nelson, & Pearson, 2004), civic and political engagement (Hunt, Simonds, & Simonds, 2009), speech evaluation assessment (Simonds, Meyer, Hunt, & Simonds, 2009), and pedagogy surrounding the basic communication course.

Clearly, instructional communication, communication education, and communication pedagogy have a shared foundation. However, instructional communication focuses on the communication involved with teaching and learning in any context; whereas, communication education is aimed at teaching students to communicate effectively. Communication pedagogy is limited strictly to the theo1y and best practices of teaching communication concepts. In order to outline the role instructional communication can play outside of communication education it is necessary to discuss the trajectory of this research line.

***Trajectory of Instructional Communication Research.*** Instructional communication is marked by a number of important milestones. While the discussion could, to some degree, start the study of rhetoric in ancient Greece, the 20th century marked the beginning of significant evolution of the communication discipline and, eventually, instructional communication research. The emergence of communication education (from which instructional communication finds many of its roots) aligns with the emergence of communication as an academic discipline (McCroskey, Richmond, & McCroskey, 2006). In 1915, the Quarterly Journal of Speech was founded to understand and improve instruction of public speaking and to analyze the rhetoric of public figures

(Eadie, 2009). Murray (1937) expanded communication research to also study interpersonal communication and its instruction.

After World War II and through the 1960s, communication scholars took note of the social science approaches which now dominated the fields of sociology and psychology, and began to apply this approach to the study of communication (Preiss & Wheeless, 2014). Continuing into the 1970s, the focus began to shift outside the classroom. At this point, Wheeless (1977) suggested distinguishing between communication pedagogy and instructional communication. Wheelesss and Hurt (1979) cemented the distinction between these two areas. During this decade, the focus of scholarship began to shift from public speaking skills and performance, instead focusing on confusion of tension, public speaking anxiety, and other factors which affect indication competency (e.g., McCroskey, 1976).

As instructional communication research developed, it struggled to move beyond the SMCR model (Source, Message, Channel, Receiver). This eventually became a key critique of the research line is the predication disciplined in general shifted to include other approaches (Preiss & Wheeless, 2014). Research largely progressed by focusing on specific variables rather than comprehensive theoretical approaches, prompting for the criticism in some corners. These factors included student characteristics such as gender and culture. The impact of instructor factors and behaviors and student learning also drove research, including the use of power and affinity seeking strategies, nonverbal immediacy, humor, and self-disclosure (Beebe & Mottet, 2009). More recently, communication scholars are recognizing the role instructional communication plays in a

variety of contexts, including training and development, health mediation, and risk and crisis communication, which is discussed in the next section.

A chief criticism of instructional communication research is that it is driven by variable analytic research. Indeed, this is a fair observation regarding quite a number of instructional communication studies, which focused on understanding how specific individual characteristics or message components impacted the instructional process (Preiss & Wheeless, 2014). Instructional communication research has also led to the development of a number of original models but, again, few original theories. However, as Sellnow and Sellnow (2014) point out in the Encyclopedia of Health Communication, these criticisms are more appropriately aimed at the shortcomings of individual studies, since more and more contemporary instructional education research is grounded in and driven by existing theory.

Still, some might argue that instructional communication is not a distinct area of scholarship because it draws too heavily on theories from other disciplines. However, this argument falls short when one considers how the rest of the communication discipline adapted theories from other disciplines. Systems theory is shared by communication and a number of disciplines, including biology. Theories such as EPPM and Weick's theory of Sensemaking (1995) overlap and draw from the field of psychology to explain cognitive processes which impact communication. Furthermore, some of the underpinnings of intercultural communication rely on the work sociologists to explain how cultural factors such as collectivism or public time influence best practices for intercultural communication.

The IDEA model (see Appendix A), specifically, draws on Experiential Learning Theory (Dewey, 1938) and the Learning Cycle Model (Kolb, 1984), both developed in the field of education. When it comes to defining the domain of instructional communication, what matters is not whether theories originated, but to what end they are used and refined. In the case of the IDEA model, although learning styles research was originally developed to understand how people learn, instructional education research employs this to understand how we can effectively communicate a message. Put another way, while education researchers may use the theory to understand the student learner and inform pedagogy, instructional communication employs the theory to improve the message and improve outcomes (Sellnow et al., 2014).

Despite the criticisms outlined above regarding the origin of certain theories, instructional communication is appropriately driven by theoretical considerations. For example, McCroskey and Richmond (1983) developed a typology of Behavioral Alteration Techniques used in the classroom. This was adapted from compliance gaining literature (Kearney et al., 1985). McCroskey, Valencic, & Richmond (2004) propose the general model of instructional communication capitalize general model of instructional to mediation which explores the interaction between a number of variables as part of the system. These include teacher temperament, communication behaviors, student perceptions, and outcomes. This line of research draws and theoretical work from communication, psychology, and sociology (Mottet & Beebee, 2006), further grounding the subfield in theoretical research.

Bloom's Taxonomy (1956) is also used in instructional communication. Similarly, Bandura's (1969) work on behavioral learning is relevant to this line of research. He

explains that student motivation increases if the student perceives the skills being taught is valuable and relevant, if they are rewarded, if the skill is attainable, and if it is performed by models similar to themselves (Bandura, 1969). The link between behavioral outcomes and instructional communication is clear, especially when it is applied to risk and crisis communication. Learning is measured by comprehension, retention, and application or behavior. Finally, Communication Accommodation Theory (Giles, Coupland, & Coupland, 1991) has also found relevance to instructional communication research by offering yet another theoretical lens through which we understand the variables impacting instruction (Morreale & Pearson, 2008).

Instructional communication differs from communication education and communication pedagogy because it concerns itself with instruction in any context. This provides tremendous opportunities for future research. One such area is risk communication. As Sellnow et al. (2014) note in their book on risk communication, the world is becoming an increasingly complex place and individuals are faced with more and more information to process. It follows that people will inevitably face unfamiliar risks originating across the globe, about which they will need to be educated and informed. Instructional communication may prove to be useful approach to build on risk and crisis communication scholarship.

***Risk Communication***. Many of the message-centered approaches to risk communication focus on building dialogue to help stakeholders understand the risk. Some research concludes that this interaction "builds trust through participation" in the decision-making process (Kasperson, Kasperson, Pidgeon, & Slovic, 2010, p.333). The National Research Council (1983) states that the essence of risk communication is "an

interactive process of exchange of information and opinion among individuals, groups, and institutions" (p. 21). During many crises, though, there is little or no time for this type of dialogic communication. This is especially true in the case of earthquakes, as there will only be seconds during which a warning message can be communicated and acted upon. Under these circumstances, the public is better served by focusing on instructional messages about self-protection (Mileti & Peek, 2000; Sellnow & Sellnow, 2010). During rapidly escalating crises, "instructing information uses strategies that seek to tell stakeholders what to do to protect themselves from the crisis" (Coombs, 2009, p.105)

Literature on warnings from the field of sociology have long focused on instructional components in messages. This theme appears in research on warnings for natural disasters (Mileti & Sorensen, 1990; Mileti, 1995) as well as during a crisis at a nuclear power plant (Mileti & Peek, 2000). There are also a number of studies from communication emphasizing the need to use a variety of media channels to distribute instructional messages to a broad audience during crises (e.g. Macintyre, Spence, & Lachlan, 2011; Seeger, Venette, Ulmer & Sellnow, 2002). While each of these studies underscore the need for messages providing instruction during a crisis, they tend to be case studies focused on message distribution during crises where risks unfold over a matter of hours and days. The present study, however, will take a message testing approach to risk communication applied to a message constrained to a much tighter timeframe – a matter of seconds.

As Sensemaking theory indicates, a crisis situation upends an individual's ability to make sense of his or her environment. Along the same lines, Hermann (1963) found

that crises consist of three elements: threat, surprise, and short response time. The sudden and often unexpected threat of a crisis can create a situation "where existing forms of sensemaking fail to account for the unforeseen experiences" (Seeger, Sellnow, & Ulmer, 2010, p. 493). Sellnow and Sellnow (2010) propose that instructional risk communication can aid the sensemaking process during these failures of sensemaking during crises.

Communication scholars are not the only ones highlighting the need for instructional messages during risk and crisis scenarios. This view has independently evolved from research on disaster warnings from the field of sociology. Mileti and Sorenson (1990) found that "warnings are more likely to be responded to with some protective action if they are understood, believed, and personalized" (p.8). Lindell (2013) found that the frequency of risk messages was more important than trying to "frighten them with messages about the severity of the consequences of exposure" (p. 125). Mileti and Peek (2000) argue that warnings must provide the public with specific recommendations for protective actions in order to be effective. They argue that, "It cannot be assumed that the public will know what would constitute an appropriate protective action. Thus, the content of an emergency warning message must include information about what people should do to protect themselves from the impending hazard" (p. 185).

***Instructional Risk Communication***. To overcome these challenges, Wrench (2007) contends that instructional communication research should be applied to the domain of risk communication. He argues that confidence in one's cognitive learning is key to empowering individuals to follow any directions they receive during a crisis (Richmond, Lane, & McCroskey, 2006). If an individual does not feel confident in their

ability to comprehend and carry out the prescribed actions in a risk message, that individual is less prepared to appropriately avoid harm. Coombs (2009) explains, "It is not as simple as disseminating information… If stakeholders do not act upon the instructing information, the damage will not be prevented or limited" (p.105). Clearly, to achieve the goals of risk communication, messages must facilitate understanding and action in an often complex, time-constrained situation.

Risk communication studies indicate, however, that risk communicators often do focus more on the total number of people harmed at the expense of providing actionable recommendations (Frisby et al., 2014; Wickline & Sellnow, 2013). Likewise, Frisby et al. (2013) find that risk messages that include specific actionable instructions can strengthen crisis messages. Sellnow et al. (2012) discovered that messages that provide practical instructions for self-protection increase confidence and willingness to take appropriate self-protective behaviors. Moreover, Frisby, Veil, and Sellnow (2014) found that participants who viewed messages containing specific instructional content reported higher levels of understanding and efficacy about the risks. On the opposite side of the coin, Slovic (2010) found that focusing on the number of people harmed without providing actionable recommendations can "seduce us into calmly turning away" from the danger instead of confronting it (p. 76).

***IDEA Model***. In order to guide the construction of instructional risk messages, Sellnow and Sellnow (2013; 2014) proposed the IDEA model (see Appendix A). This model finds its roots in experiential learning theory and learning styles research (Sellnow et al., 2014). Dewey's (1934) Experiential Learning theory contends that learning happens when receivers not only understand information, but remember it and use it

appropriately. Of course, this aligns well with the goals of risk communication outlined above. Building on Dewey's work, Kolb (1984) proposed that individuals learn through a four-stage cycle comprised of concrete experience, reflective observation, abstract conceptualization, and active experimentation. Sellnow et al. (2014) describe these steps as feeling, watching, thinking, and doing. From this, they proposed the IDEA model as a simple and easy-to-remember tool for use when communicating risk messages to the public. Drawing on Kolb (1984) and Dewey (1934), they propose four essential elements to address when constructing instructional risk messages: internalization (I), distribution (D), explanation (E), and action (A).

According to Sellnow et al. (2013), internalization "focuses on gaining and maintaining audience attention by demonstrating the relevance of the potential risk to them" (p.3). Relevance may highlight the severity of the impact, proximity to the risk, and timeliness. Distribution, of course, focuses on selecting an appropriate mix of communication channels to reach the specific desired audience in a timely fashion. Explanation deals with answering the basic questions about a risk or crisis scenario: What is happening and what is the response? Sellnow & Sellnow (2014) argue that the explanations should come from credible sources, be honest and accurate, and use language that the target population understands. Finally, the action step answers "What, precisely, should I do to protect myself?" In the case of earthquake early warning, such instructions would likely be "drop, cover, and hold on!" By using the IDEA model to craft risk messages, communicators will be more likely to present clear and persuasive risk messages.

Some preliminary research has investigated the utility of the IDEA model for risk communication. Sellnow et al. (2014) usd quaisi-experimental methods to understand how participants reacted to IDEA model messages about an outbreak of foodborne illness. That study revealed that the IDEA model messages were more effective than their control messages which focused on the impact of the outbreak and the number of people affected. Also, Wilson (2014) studied the IDEA model's impact on message convergence and positive sensemaking, finding that participants who received an IDEA model message in addition to supporting Twitter messages were more likely to take action compared to individuals who received a traditional video warning message.

**Unique Challenges of Earthquake Early Warning**

The previous studies indicate that the IDEA model may improve risk communication during slowly-evolving food safety crises. More work needs to be done, however, to show the utility of the IDEA model during other types of risk and crisis scenarios. Indeed, earthquake early warning presents unique challenges. Chiefly, the rapid nature of earthquakes means that individuals will have, perhaps, tens of seconds to receive, interpret, and act on a warning message. Crafting an IDEA model message to fit, much less work, in ten seconds or less, is a very different set of circumstances than the food safety scenarios previously investigated. Moreover, the highly technical language used to describe earthquake risks (magnitude, intensity, p-waves, s-waves, etc.) may also impact the effectiveness of this model. Thus, this study builds on previous research to ask a number of important questions concerning how individuals make sense of IDEA model messages in such a short time span.

**Research Questions and Hypotheses**

The IDEA model proposes that messages are successful when they holistically focus on internalization, explanation, and action. For this study, that equates to message importance, perceived knowledge, self-efficacy and behavioral intentions. Thus, the following hypotheses are proposed:

*H1a*: Participants who view the IDEA model message will report higher self-efficacy after viewing the message compared to the control condition.

*H1b*: Participants who view the IDEA model message will report greater understanding of the risks associated with earthquakes compared to participants who view the control condition.

*H1c*: Participants who view the IDEA model message will report perceiving the message as important compared to the participants who view the control condition.

*H1d*: Participants who view the IDEA model message will report a high likelihood that they will take protective action after viewing the message compared to the control condition.

*H1e*: Participants who view the IDEA model message are more likely to take protective action in accordance with USGS recommendations for earthquakes than those who viewed the control condition.

There is also an opportunity to explore how sensemaking explains participants' response to an IDEA model message. Building on the work of Wilson (2014) who proposed a value-laden approach to analyzing sensemaking, we can attempt to answer the

question: is there an indication that people are making sense of the message in the short timeframe, and that such sensemaking impacts their response?

*H2a:* Participants who view the IDEA model message are more likely to make positive sense of the message than those who view the control condition.

*H2b*: Participants who make positive sense of the IDEA model message will report greater self-efficacy than those who do not report positive sensemaking.

*H2c*: Participants who make positive sense of the control message will report greater self-efficacy than those who do not report positive sensemaking.

*H2d*: Participants who make positive sense of the IDEA model message will report greater behavioral intention in line with USGS recommendations than those who do not report positive sensemaking.

*H2e*: Participants who make positive sense of the control message will report greater behavioral intention in line with USGS recommendations than those who do not report positive sensemaking when viewing the control.

**Chapter Summary**

This chapter explored previous literature pertaining to risk communication and the role of instructional communication research in risk messages. By reviewing the process and properties of sensemaking, this chapter outlined how individuals make sense of their surroundings and make decisions during crises. Next, the chapter explored risk communication research, which aims to guide the sensemaking process in order to persuade people to take appropriate action. Finally, the chapter outlined the role that instructional communication can play in risk communication, introducing the IDEA

model and posing research hypotheses to investigate how the IDEA model contributes to instructional risk communication.

## Chapter 3: Methods

In order to test the research questions and hypotheses posed in the previous chapter, this study employed a quasi-experimental survey design. This chapter details the procedures through which the data were collected, including the research design, participants, measures, data collection, and data analysis techniques.

### Research Design

Participants were randomly assigned through Qualtrics, an electronic survey interface, to interact with one of four experimental message conditions or a control condition. Each experimental condition employs all the elements of the IDEA model, but arranges the components in different ways (see Appendix B). Participants were distributed equally between the four conditions.

***Stimulus materials***. Four conditions were set up to test the effect of the IDEA model as a design for earthquake early warning messages (See Appendix C). Some conditions contain a map showing the relative location of the earthquake, while others do not contain a map. Some conditions indicate earthquake intensity with a numerical value, while some indicate intensity in a non-numerical method. Some of the conditions use a numerical countdown while others use a graphic representation of a clock. Finally, there are actionable instructions in all message conditions, which say "drop, cover, hold on" and use the same graphic used by the USGS for that message. These four conditions were tested against a control condition, which uses the existing ShakeAlert prototype warning system. That system was not designed using the IDEA model and, therefore, served as a meaningful control condition.

The messages were displayed on a computer screen, and are designed to look like they would appear on a smartphone. An audio message plays while the participant views the message, first playing an alert tone, followed by the directions "drop, cover, and hold on." These prototype graphics are not animated, meaning that the countdown timer, for example, does not move in the mock-up that participants view. Participants were given an unlimited amount of time to view the message, though the messages are designed to be delivered in under ten seconds.

**Participants**

Participants were recruited using snowball sampling, primarily via Facebook and relying on USGS officials in Southern California and Shakeout, a resource targeted toward Southern California. The goal of the study is to sample participants from Southern California. In addition to targeting Facebook pages and groups where those users are present, a demographic question was included to filter responses based on the participant's location.

The completed responses used in this analysis were collected between June 19, 2014 and October 11, 2014. Participants ($n$ = 261) included 108 males and 171 females, as well as six participants who chose not to disclose their gender. The majority of participants identified as Caucasian (86.3%; $n$ = 246), while 4.2% ($n$ = 12) described themselves as Asian or Asian American, 3.9% ($n$ = 11) described themselves as Latino/Hispanic, 1.1% ($n$ = 3) described themselves as African-American, while 2.3% ($n$ = 6) selected "other." A majority of respondents were residents of Southern California (66.3%; $n$ = 189) and 30% ($n$ = 87) described themselves as life-long residents of that area. Respondents ranged in age from 19 to 81 years old. Participants were also asked to

report their approximate family income. 33.7% of respondents ($n$ = 96) reported that their family income was greater than $100,000 per year, while 14% ($n$ = 40) earned $70,000 – $100,000, 14% ($n$ = 40) earned 50,000 – 70,000 and 14.4% ($n$ = 41) earned less than $30,000 per year.

**Measures**

***Self-efficacy***. This measure was employed to answer hypotheses *H1a, H2b* and *H2c*. The ten-item scale used to measure self-efficacy has evolved from a number of risk communication studies. The scale employed here was first used to study risk communication surrounding lettuce contaminations (Frisby et al., 2011; Veil et al., 2011). Wilson (2014) later adapted the scale to cover a similar outbreak scenario by adapting it to an E. coli outbreak in ground beef. While earthquake warnings represent a very different risk context, this scale nonetheless translates well for use in the present study. Participants responded using a five-point Likert-type scale ranging from "strongly disagree" (1) to "strongly agree" (5). Example items for this measure include: "When strong shaking begins, I believe I can master the skills to protect myself from an earthquake" and "Nothing I can do will protect me during an earthquake." This unidimensional, 10-item scale was reliable ($\alpha$ = .862, $M$ = 4.416, $SD$ = .023).

***Knowledge***. This measure corresponds to research hypothesis *H1b* and is also a component of the "positive sensemaking" variable discussed later in this section. These items were originally used by Wrench (2007), and adapted by Wilson (2014) to measure an individual's perceived knowledge relating to the risk in question. Participants responded using a five-point Likert-type scale ranging from "strongly disagree" (1) to "strongly agree" (5). Example items for this measure include: "I know the risks involved

with earthquakes" and "My knowledge of the risks involved with earthquakes is limited." This scale was reliable (α = .955, *M* = 4.476, *SD* = .009).

***Message importance***. To answer research hypothesis *H1c*, this study measured the participants' perceptions of the importance of four message characteristics: the countdown timer, intensity, location, and the strength of expected shaking. This measure also contributes to the "positive sensemaking" variable discussed later in this section. Participants responded using a five-point Likert-type scale ranging from "not at all important" (1) to "extremely important" (5) for each of these message components. Example items for this measure include: "How important is it for you to know what kind of shaking is likely to occur?" and "How important is it for you to know the number of seconds remaining until the shaking will begin?"

***Behavioral intentions*.** This survey measured the participants' behavioral intentions after viewing the message using a nine-item scale developed for health communication (Harris, 2007; Noar et al., 2010) and adapted by Wilson (2014) in order to answer research hypothesis *H1d, H1e, H2d, and H2e.* The scale was adapted to fit the context of this study of earthquake warnings. Participants responded using a five-point Likert-type scale ranging from "strongly disagree" (1) to "strongly agree" (5). These questions were used to analyze the research questions pertaining to behavioral intent and sensemaking. Example items for this measure include: "I would take no action after receiving an earthquake warning for severe shaking," and "I would take cover upon receiving an earthquake warning for severe shaking." This unidimensional, nine-item scale exhibited marginal reliability (α = .606, *M* = 4.049, *SD* = .73).

Certain items from this scale conform to the protective actions recommended by the USGS ("drop, cover, hold on"). These items were used to answer research hypotheses *H1d, H2d,* and *H2e*. Items from this scale which do not match those recommended actions (i.e., "I would immediately try to call or text a friend…") were not included to answer this hypothesis. The four items used for this sub-scale exhibited acceptable reliability ($\alpha = .703$, $M = 4.59$, $SD = .024$).

***Sensemaking***. Weick (1979, 1995) originally operationalized sensemaking as a value-neutral concept, and most studies of sensemaking have used qualitative methods (Coffelt et al, 2011). In the context of risk communication, however, it is logical to make value judgements about the products of sensemaking. If the participant makes sense of the situation in the way the risk message intends, then we can consider that "positive sensemaking" (Wilson, 2014, p. 56). In order to determine whether sensemaking is "positive" or "negative," this study compiled the results of three other scales described in this section.

Wilson (2014) uses four scales to create a sensemaking variable: message importance, effectiveness, knowledge, and likelihood to talk about the outbreak. The first three items of this scale make sense in the context of earthquake warnings. "Likelihood to talk…", however, was developed in the context of a foodborne illness outbreak, and does not fit this scenario due to the extreme time constraints in which the risk message must be received, interpreted, and acted upon. Therefore, this study re-conceptualized sensemaking using only the scales for message importance, message effectiveness, and perceived knowledge. Perceived importance indicates how likely the participant is to engage in sensemaking about the risk. Message effectiveness and perceived knowledge

scales indicate how well the participant enacted with the message, and if they were able to make sense of that message. Operationalizing sensemaking through these three measures will allow sensemaking to be evaluated using quantitative methods in order to answer this study's research hypotheses. Composite means for each of the three component scales were evaluated where participants whose mean score for each of the three scales was greater than 3.0 were determined to have made "positive sense" of the message. Likewise, a score less than 3.0 indicated that the individual did not make positive sense of the message, while a score of exactly 3.0 was labeled "neutral."

***Perceived Effectiveness***. To respond to the second hypothesis, nine items were employed to measure participants' perception that the message was effective. These items have been adapted from Sellnow et al. (2012, 2013). Participants responded using a five-point Likert-type scale ranging from "not helpful" (1) to "very helpful" (5). Example items for this measure include: "How helpful were the visual images in conveying this information about shaking?" and "How well do you understand the meaning of the different intensity numbers." This unidimensional, nine-item scale was reliable ($\alpha = .810$, $M = 4.064$, $SD = .70$).

**Procedures**

***Data collection***. After approval from the University of Kentucky Institutional Review Board, participants accessed the survey by clicking on a link where they encounter the survey invitation (i.e., when they see it on Facebook). When the participant clicked that link, they viewed a welcome message introducing the study and explaining that it will take approximately 18 minutes to complete. After viewing the welcome

message, participants were asked to consent to participating, and they were brought to a screen which asked them to check that their sound is working.

At this point, participants were asked pre-manipulation questions to assess their prior knowledge about earthquakes. After completing this series of questions, participants then viewed and heard one of the message conditions. After viewing the message, participants completed a number of post-manipulation survey items relating to their knowledge, attitudes, believes, behavioral intentions, and demographic information.

***Data analysis***. One-way between-subjects ANOVAs were used to analyze the first and second research hypotheses. For example, to test hypothesis 1a, there were five conditions for the independent variable (four IDEA model messages plus a control condition), to determine the effect of each message condition on self-efficacy. Similarly designed one-way between-subjects ANOVAs were used to determine the effect of message condition on the respective dependent variables. Hypothesis 2a, however, was be analyzed using a chi-square analysis because the two variables involved are both nominal and dichotomous.

## Chapter Summary

This chapter provided an overview of the research design used in this study. The chapter discusses the selection process for participants, the measures used to collect data, the procedures for data collection and sampling, and the methods used for analysis. The next chapter of this study will report the results of these analyses.

## Chapter 4: Results

Each hypothesis was analyzed using a one-way between-subjects ANOVA. The results from each of these tests are discussed in this chapter.

### Hypothesis One

The first set of hypotheses predict that participants who view the IDEA model message will report greater levels of knowledge, understanding of risks, perception of message importance, and behavioral intentions. To address the first hypothesis, a one-way between-subjects ANOVA was calculated. Findings indicate no significant difference between participants who viewed the control message and those who viewed the IDEA model message. Specific to perceived self-efficacy (*H1a*), there was no measurable difference among participants who viewed the IDEA model message (M = 4.44, SD = .56) compared to those who viewed the control message (M = 4.35, SD = .51)[$F(1, 282)= 1.21$, $p>.05$, $\eta^2 = .004$]. Therefore, hypothesis H1a was not supported.

Hypothesis H1b predicts that participants who view the IDEA model message will report greater understanding of the risks associated with earthquakes compared to participants who view the control condition. When measuring perceived knowledge, there was no discernable difference between participants who viewed the IDEA model message (M = 4.46, SD = .72) and those who viewed the control message (M = 4.54, SD = .67)[$F(1, 284) = .626$, $p >.05$, $\eta^2 = .002$]. Therefore, hypothesis H1b was not supported.

Hypothesis H1c predicts that participants who view the IDEA model message will report perceiving the message as more important than those who view the control condition. Likewise, when rating the perceived importance of the message, there was no measurable difference between participants who viewed the IDEA model message (M =

3.45, SD = 1.61) compared to those who viewed the control (M = 3.57, SD = 1.69)[$F(1,279) = .277$, P>05, $\eta^2 = .599$]. Therefore, hypothesis H1c was not supported.

Hypothesis H1d predicted that participants who view the IDEA model message will report a higher likelihood that they will take some protective action compared to those who viewed the control condition. Participants who viewed the IDEA model message reported no measurable differences regarding their likelihood to take action after hearing the message (M = 4.06, SD = .63) compared to those who viewed the control (M = 4.02, SD = .54)[$F(1,283) = .304$, p>.05, $\eta^2 = .001$]. Therefore, hypothesis H1d was not supported.

Similar to hypothesis H1d, hypothesis H1e predicts that participants who view the IDEA model message are more likely to take *appropriate* protective action after viewing the IDEA model message compared to those who view the control message. When behavioral intention is measured using only those actions recommended by the app, participants who view the IDEA model message once again report only slightly higher levels of behavioral intention (M = 4.61, SD = .56) compared to those who view the control (M = 4.52, SD = .54)[$F(1,283) = .375$, p>.05, $\eta^2 = .003$]. Therefore, hypothesis H1e was not supported.

**Hypothesis Two**

The second set of hypotheses focus on sensemaking. Hypothesis H2a predicts that participants who view an IDEA model message are more likely to make positive sense of the message than those who view the control condition. A chi-square analysis was used to analyze the relationship between these two nominal variables (positive or negative sensemaking on one axis and IDEA message or control message

**Table 4.1, One-way ANOVA Results for the IDEA Model Message and the Control Message**

| | IDEA | | Control | | | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | *M* | *SD* | *M* | *SD* | *F* | *df* | *p* | $\eta^2$ |
| Knowledge | 4.46 | .72 | 4.54 | .68 | .63 | 1, 284 | .43 | .004 |
| Self-efficacy | 4.44 | .56 | 4.35 | .51 | 1.21 | 1,283 | .58 | .002 |
| Behavioral Intention | 4.06 | .54 | 4.02 | .51 | .30 | 1, 283 | .32 | .599 |
| Appropriate Behavioral Intention | 4.61 | .63 | 4.52 | .54 | 1.00 | 1, 281 | .27 | .001 |
| Message Importance | 3.45 | 1.61 | 3.57 | 1.69 | .28 | 1, 279 | .60 | .003 |

on the other axis). The chi-square analysis showed no significant relationship between sensemaking and message condition ($\chi^2 = 0.096$, df = 1, $p > .05$). Therefore, hypothesis H2a is not supported.

Hypotheses H2b predicts that participants who are able to make positive sense of the message ($n = 192$) will report greater self-efficacy than participants who did not make positive sense ($n = 78$). A one-way between-subjects ANOVA revealed no significant difference in perceived self-efficacy between those who made positive sense of the message ($M = 4.45$, $SD = .56$) and those who did not ($M = 4.40$, $SD = .58$) [$F$ (1, 208) = .38, $p > .05$, $\eta^2 = .0018$]. Therefore, hypotheses H2b was not supported.

Hypothesis H2c predicts that participants who make positive sense of the IDEA model message will report greater levels of appropriate behavioral intention than those who do not make positive sense of the message. A one-way, between-subjects ANOVA revealed no significant differences between those who made positive sense of the message ($M = 4.60$, $SD = .68$) and those who did not ($M = 4.67$, $SD = .44$) [$F$(1, 208) = .70, $p > .05$, $\eta^2 = .003$]. Therefore, hypothesis H2c was not supported.

Hypothesis H2d predicts that participants who make positive sense of the control message will also report greater levels of appropriate behavioral intention than those who do not report positive sensemaking. A one-way, between-subjects ANOVA was conducted to examine this relationship. The test revealed no significant differences between those participants who made positive sense of the message ($M = 4.56$, $SD = .53$) and those who did not make positive sense of the message ($M = 4.37$, $SD = .58$)[$F = (1,58) = 1.45$, $p > .05$, $\eta^2 = .02$]. Therefore, hypothesis *H2d* was not supported.

**Table 4.2, One-way ANOVA Results for Positive Sensemaking of the IDEA Model Message and the Control Message**

| | Positive Sensemaking | | Negative Sensemaking | | | | | |
|---|---|---|---|---|---|---|---|---|
| Variable | *M* | *SD* | *M* | *SD* | *F* | *df* | *p* | $\eta^2$ |
| Self-efficacy – IDEA | 4.45 | .56 | 4.40 | .58 | .38 | 1 | .53 | .001 |
| Self-efficacy - Control | 4.39 | .48 | 4.17 | .56 | 2.33 | 1 | .13 | .039 |
| Appropriate Behavioral Intention - IDEA | 4.60 | .68 | 4.68 | .44 | .69 | 1 | .40 | .003 |
| Appropriate Behavioral Intention - Control | 4.56 | .53 | 4.38 | .58 | 1.45 | 1 | .23 | .025 |

## Chapter Summary

This chapter reported the results of the statistical tests used to answer each hypothesis. The study found no statistically significant results for any of the hypotheses when analyzing the results of the survey. The next chapter will discuss the implications of these findings on future research and application of the IDEA model and instructional risk communication.

## Chapter Five: Discussion, Implications, and Conclusions

This dissertation explored how the IDEA model can contribute to effective message design for earthquake warnings. This study further explored the concept of positive sensemaking and its relationship to attitudes and behavioral intentions relating to the earthquake warning message. The results describe how message design and positive sensemaking influence decision making when participants view an earthquake early warning message. While the results are largely inconclusive, this study does reveal an opportunity for future research surrounding the use of the IDEA model in crisis communication messages, as well as the continued study of sensemaking as a value-laden, quantitative construct. This chapter will begin by discussing the practical implications of this study's results while drawing connections to theoretical research on sensemaking and instructional risk communication. Next, the limitations of the research will be discussed, followed by opportunities for future research and the conclusion.

### Implications

Like many crisis communication studies, the findings for this research are both applied and theoretical in nature. Eadie (1982) explains that, "applied communication research is always theoretically informed, its goal rests with explaining to the greatest extent possible what is going on with regard to a particular problem" (p.4). Even though there were no statistically significant findings in this dissertation, the findings and implications from this study can be applied to future risk and crisis communication studies, especially those relating to natural hazards and time constrained messages.

***IDEA Model Message Design.*** The results related to the IDEA model of message design can be applied to the future design and research of crisis communication messages. The components of the IDEA model (Internalization, Distribution,

Explanation, and Action) are meant to serve as a guide for message developers in creating messages that enhance receivers' perceptions of self-efficacy and to persuade them to take protective action. Previous studies (e.g., Wilson, 2014; Sellnow et al., 2014) found that risk and crisis messages utilizing the IDEA model for message design may positively affect receivers' attitudes, beliefs, and behavioral intentions toward message recommendations. These studies, both relating to food safety messages, found that messages designed using the IDEA model were more likely to spur message receivers to take protective action or change their attitudes. Similar to the design of this study, the IDEA model for message design has been previously tested and compared to messages that do not conform to IDEA model standards (Sellnow & Sellnow, 2010; Sellnow et al., 2012, Sellnow et al., 2013; Wilson, 2014). Those studies showed that the IDEA model works well in the context of risk communication regarding food safety. The present study used similar methods in a much different context, earthquake warnings. While the findings of this study were not significant, there is no indication that those results negate the promising results of previous research on the IDEA model. Instead, it appears that the lack of significant results may be due to issues stemming from sample characteristics and limitations of the survey instruments used. Those limitations and suggestions for future research are discussed later in this section.

***Positive Sensemaking.*** Weick (1995) originally posed sensemaking as a value-neutral construct through which individuals make sense of a crisis. Weick (1995) goes on to theorize how sensemaking affects those individuals' attitudes, beliefs, and behaviors relating to that crisis. Building on the work of Wilson (2014), this study adapted sensemaking as a value-laden construct in order to explain differences in attitudes and behavioral intentions between participants who made positive sense of the message and those who did not make positive sense of the message. Weick intended sensemaking to

explain how individuals make sense, retrospectively, of their experiences. However, using Wilson's (2014) future-perfect conceptualization gives researchers the ability to use this theory to explain why some individuals engage in protective behavior while others do not. If communication scholarship can develop a test for positive sensemaking and identify those message elements that contribute to it, those elements could be included in future crisis messages to spur positive sense among message recipients. As a receiver-based approach, the IDEA model is well-situated to incorporate such findings if they are discovered.

Similar to Wilson's (2014) research, this study also reveals potential cause for concern in employing a concept of positive sense. As she points out, one concern is that sensemaking is based on plausibility rather than accuracy. The results of the second hypothesis hint at this issue. A plausible interpretation of a message is not necessarily the most accurate or helpful. While the results lack significance, this study revealed that participants who made positive sense of the message were just as likely to take inappropriate actions after receiving the warning message as those who did not make positive sense of the message. For example, participants responded that they would likely call or text a loved-one after receiving the warning message, or they would attempt to seek out more information. These are not behaviors encouraged by the warning message and, moreover, they put those individuals at risk by distracting them from taking appropriate protective action in the few seconds prior to the onset of shaking from the earthquake.

It is possible that participants' various levels of risk tolerance factored into these responses. Individuals accustomed to earthquakes may feel more confident and capable of taking other actions during the warning period compared to individuals who are less

experienced with earthquakes. Another possible explanation is that the instrument used to survey participants was unclear. The questions relevant to this hypothesis do not clearly state that these actions would take place prior to the arrival of the shockwave. Therefore, depending on one's interpretation of the question, checking other sources and texting friends and family may, in fact, be an appropriate response if the participant believes they are taking place after the earthquake has subsided. Future studies should be careful to clarify this, given the time constraints assumed for earthquake warnings.

**Limitations of Research**

While this study does provide further insight into the use of the IDEA model for crisis communication, there are some notable limitations. The first limitation stems from the snowball sample used to gather responses. The responses gathered are not representative of the population of southern California. Compared to census data from the area, the sample obtained for this study is much more Caucasian, affluent, and well-educated than the general population in southern California. Nonetheless, the participants surveyed for this study are, in fact, part of the target audience for an eventual earthquake early warning app. Therefore, the results of this study are still valid for those segments of the population who are represented in this sample. It is important, however, that future research use more robust sampling methods in order to obtain a more representative sample. Previous risk and crisis communication research has shown that sociocultural and demographic factors often influence a population's response to a risk or crisis message (Lachlan & Spence, 2011; Littlefield et al., 2014). Further research is needed to test this model with a more diverse sample to uncover potential receiver-based barriers to its effectiveness.

Another limitation stems from the technology used to display the messages. Each warning message was simulated using an animated representation of a smartphone screen within the participant's web browser. For this study, participants were able to view that message as many times as they wished. In practice, users would only have tens of seconds, at most, to receive and interpret that message. This difference could impact a number of factors, especially hypothesis two which measured sensemaking. Users who may have been confused by the message had the opportunity to re-watch the message and, perhaps, even look up confusing technical terms like intensity in another browser window. These factors limit this study's ability to accurately gauge comprehension and sensemaking for what will be, in practice, an extremely time-constrained message. Therefore, future studies should consider utilizing a more controlled environment, perhaps by handing participants smartphones loaded with the warning message, and allowing it to be played only once.

A third limitation stems from the relatively simple process used for message testing compared to other studies of the IDEA model. As noted by other stakeholders involved in the earthquake early warning project, these warning messages will not be the receiver's first exposure to information about protective actions in response to an earthquake. Public education campaigns such as Shake Out aim to educate the public about the dangers posed by earthquakes and appropriate protective actions. This campaign and others will certainly accompany the rollout of any earthquake early warning app. Therefore, it may be more beneficial to test these messages at some point after participants have received information from a public education campaign. Previous studies of the IDEA model pertaining to message convergence showed positive results,

indicating that prior exposure to these concepts and messages can influence the effectiveness of later messages (Sellnow et al., 2014).

**Future Research**

The findings and limitations from this study of earthquake early warning messages designed using the IDEA model illuminate potential areas for future research. First, future studies should endeavor to obtain a more representative sample. This is a somewhat common theme among communication research, which tends to overrepresent college-age white males (Fowler, 2009). In the context of earthquake early warning in southern California, those most likely to suffer disproportionately from an earthquake are low-income residents, many of whom may not be proficient in English. While the low-income Native American population studied by Sellnow et al. (2012) is helpful in understanding how instructional risk communication is received by underrepresented populations, neither it nor the present study addresses the particular populations in question for earthquake early warnings. Future research might consider drawing on the successes of public health researchers in reaching underrepresented populations (e.g., Ka'opua, Mitschke, & Lono, 2004) or by using more labor intensive methods such as administering paper surveys in person to improve response rates (Kassing, 2009; Hoonaker & Carayon, 2009).

The lack of statistically significant differences between IDEA model messages and the control message may be a problem of riches. The treatment IDEA model message and the control condition are all well-constructed messages that provide clear information about the threat. This is further indicated by the positive scores reported by participants regarding any facet of each condition. While the control condition does not provide recommended protective actions, users familiar with earthquakes may already know or

feel that they know what to do based on their past experiences. Future research may attempt to ascertain participants' specific beliefs about particular protective actions for earthquakes prior to viewing the intervention, rather than surveying their perceived level of knowledge about earthquake safety. This would help to provide a baseline from which to compare responses among participants with varying levels of risk tolerance and varying beliefs about earthquake safety.

A unique feature of this study compared to other research examining the IDEA model is the extremely time-limited nature of earthquake warnings. The present study was inconclusive as to whether the IDEA model is better than the control condition for acute, immediate warning messages. Previous studies, however, have shown promising results when the IDEA model is employed for longer-lived crises, such as outbreaks of foodborne illness (Sellnow et al., 2014; Wilson, 2014). Therefore, future research should investigate the utility of the IDEA model to construct risk messages for public education campaigns about earthquakes. The IDEA model's effectiveness in a long-running public campaign such as Shake Out could also be compared to future studies using the IDEA model in these extremely short-lived warning messages. This would offer more insight into the utility of the IDEA model compared to other models for message construction in time-constrained crisis situations.

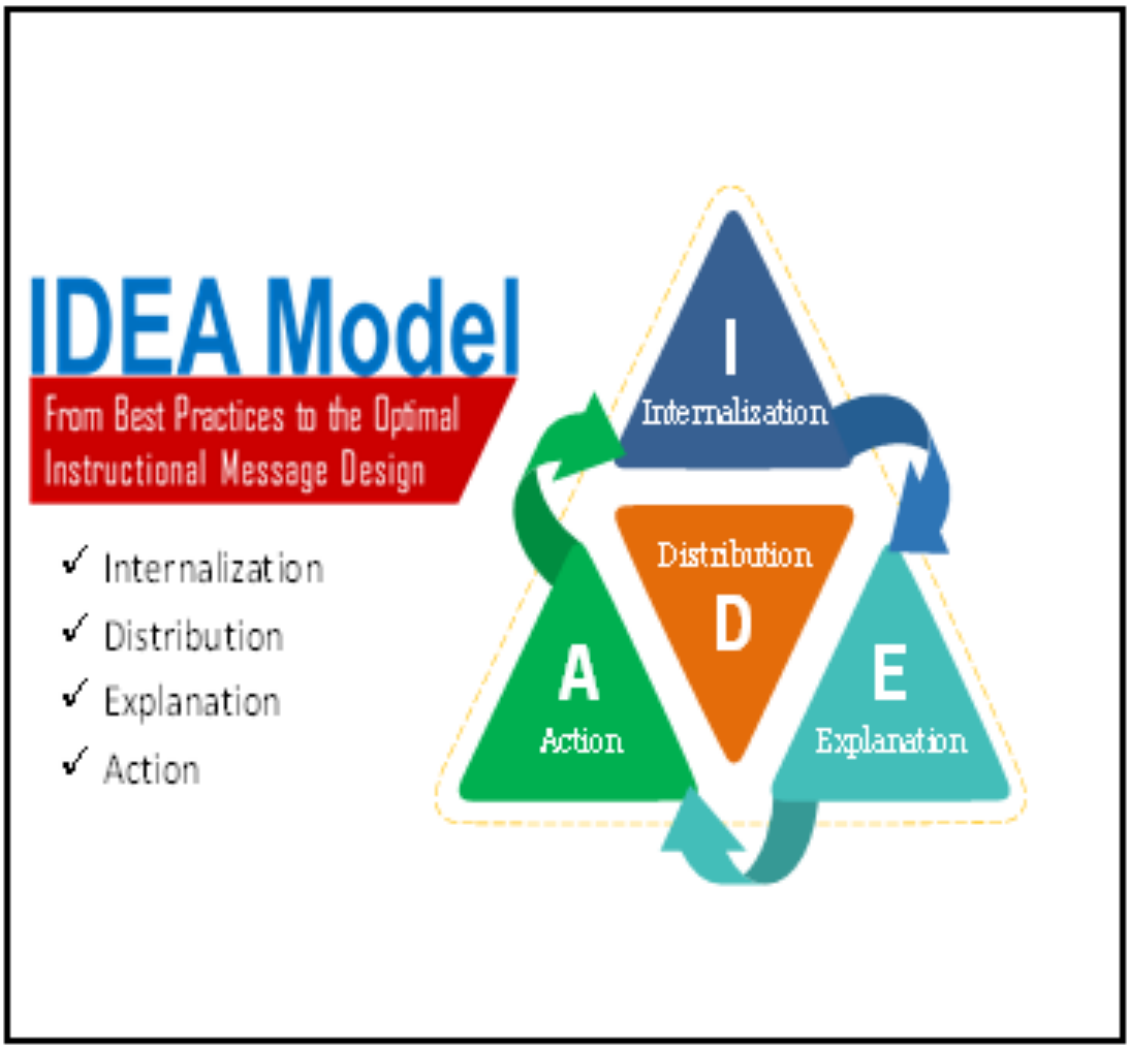
Finally, further testing is needed to develop a value-laden construct of sensemaking. The goal of a value-laden approach to sensemaking, as proposed by Wilson (2014), is to create a construct with predictive value. Determining if positive sensemaking, in fact, predicts a receiver's appropriate protective action would have a substantial impact on crisis communication research and practice. This study examined what impact positive sensemaking had on behavioral outcomes versus the outcomes for

participants who did not make positive sense of the message. While those findings are important, future research should focus on the specific factors which contribute to a receiver's ability to make positive sense of a message. Which elements of the message, for example, encourage positive sense to be made? What situational or receiver characteristics encourage positive sensemaking? Answering such questions will be an important next steep in this line of instructional risk communication research.

**Conclusion**

This dissertation set out to build on previous research which provides support for the use of the IDEA model in message construction. This study also carries forward the work of Wilson (2014) to extend sensemaking research as a value-laden construct. While none of the findings in this study were statistically significant, the research did elucidate a number of issues facing message design and, in particular, message testing for acute earthquake early warning messages. At the very least, this study supports the use of the IDEA model as a tool which provides utility for crisis communicators as a method to conceptualize and construct their messages using an audience-based approach. While the IDEA model has shown promise for risk messages such as foodborne illness outbreaks, further research is needed to understand how it can be utilized in an acute, time-constrained scenario such as earthquake early warning. If the IDEA model can be as effective in earthquake early warning as it has been shown to be in food safety scenarios, there is potential for this model to play a role in saving many lives.

**Appendix A: IDEA Model**




From Sellnow & Sellnow, (2013).

**Appendix B: Survey**

Hello,

You are reading this page because you have followed a link posted online. The following is a study examining perceptions of an earthquake warning app.

Although you will not get personal benefit from taking part in this research study, your responses may help us understand more about attitudes towards mediated warnings.

We hope to receive completed questionnaires from about 3,000 people, so your answers are important to us. Of course, you have a choice about whether or not to complete the survey/questionnaire, but if you do participate, you are free to skip any questions or discontinue at any time.

The survey/questionnaire will take no longer than 18

minutes to complete. There are no known risks to

participating in this study.

Your response to the survey is confidential. No names are collected and therefore will not appear or be used on research documents, or be used in presentations or publications.

We will keep private all research records that identify you to the extent allowed by law. However we may be required to show information which identifies you to people who need to be sure we have done the research correctly; these would be people from such organizations as the University of Kentucky.

Please be aware, while we make every effort to safeguard your data once received from the online survey/data gathering company, given the nature of online surveys, as with anything involving the Internet, we can never guarantee the confidentiality of the data while still on the survey/data gathering company's servers, or while en route to either them or us. It is also possible the raw data collected for research purposes may be used for marketing or reporting purposes by the survey/data gathering company after the research is concluded, depending on the

company's Terms of Service and Privacy policies.

If you have questions about the study, please feel free to ask; my contact information is given below. If you have complaints, suggestions, or questions about your rights as a research volunteer, contact the staff in the University of Kentucky Office of Research Integrity at

859-257-9428 or toll-free at 1-866-400-9428.Thank you in advance for your assistance with this important project.

Sincerely,

Deann Sellnow

Division of Instructional Communication & Research

*Department of Communication*

University of Kentucky

E-MAIL: Deanna.sellnow@uky.edu

Thank you for participating in this research study in cooperation with the United States Geological Survey and the University of Kentucky. We are investigating features of a USGS Earthquake Early Warning App. The purpose of this study is to find out what you think about specific features of a proposed earthquake warning smartphone app. On the next page, you are going to see a still image of a smartphone app with an audio message. After you view this image, you will be asked some questions about earthquake preparedness.

This contents of this study are best viewed on a computer or tablet and not a mobile device.

## Sound-check

At a later point in this study you will be asked to view a still image of a smartphone app with an audio message. Before we begin, please check to be sure that your sound is working. If you do not hear sound, please adjust the volume settings on your computer, check your headphones to be sure they are plugged in.

Please rate your knowledge level concerning the risk of earthquakes using the scale below.

| | Strongly Disagree | | 3 | | Strongly |
|---|---|---|---|---|---|
| I know the risks involved with earthquakes. | | | | | |
| I do not feel knowledgeable about the risks involved with earthquakes. | | | | | |
| The risks involved with earthquakes are | | | | | |
| clear to me. I do not know the risks | | | | | |
| involved with earthquakes. | | | | | |
| I do not comprehend the risks involved with earthquakes. | | | | | |
| My knowledge of the risks involved with earthquakes is limited. | | | | | |
| I understand the risks involved with earthquakes. | | | | | |
| I feel knowledgeable about the risks involved with | | | | | |

When you select continue you will be taken to a page with a still image of a smartphone app with an audio message. Please take your time to scroll around the app and view it entirely. If the video ends and you wish to view it again, just place your mouse over the video box and click it again.

Please respond to the following questions focused on the effectiveness of the App design you just viewed.

| | Very Strong | Moderate Shakin | Shakin | No | D |
|---|---|---|---|---|---|
| According to the App you just viewed, what kind of | | | | | |

| | Very | 2 | 3 | 4 | Not |
|---|---|---|---|---|---|
| How important is it for you to know what kind of | | | | | |

Please respond to the following questions focused on the effectiveness of the App design you just viewed.

| | Very | 2 | 3 | 4 | Not |
|---|---|---|---|---|---|
| How helpful was the speaker in conveying this information about shaking? | ○ | ○ | ○ | ○ | ○ |

| | on't |
|---|---|
| According to the App you just viewed, what is the | ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ ○ |

| | Very | 4 | 3 | 2 | Not |
|---|---|---|---|---|---|
| How important is it for you to know the intensitv | ○ | ○ | ○ | ○ | ○ |

| | Ver v | 4 | 3 | 2 | Don't Understa |
|---|---|---|---|---|---|
| How well do you understand the meaning of different | ○ | ○ | ○ | ○ | ○ |

| | Very | 2 | 3 | 4 | Not |
|---|---|---|---|---|---|
| How helpful was the speaker in conveying this information about intensity? | ○ | ○ | ○ | ○ | ○ |

Please respond to the following questions focused on the effectiveness of the App design you just viewed.

| | San Francis | Are | L o Are | San Are | Kno |
|---|---|---|---|---|---|
| According to the App you just viewed, where is the | ○ | ○ | ○ | ○ | ○ |

| | Very | 2 | 3 | 4 | Not |
|---|---|---|---|---|---|
| How helpful was the speaker in conveying this | ○ | ○ | ○ | ○ | ○ |
| information about location? | ○ | ○ | ○ | ○ | ○ |

| | Very | 4 | 3 | 2 | Not |
|---|---|---|---|---|---|
| How important is it for you to see a map indicating | ○ | ○ | ○ | ○ | ○ |

Please respond to the following questions focused on the effectiveness of the App design you just viewed.

| | 20 | 15 | | 10 | 5 |
|---|---|---|---|---|---|
| | | Don't | | | |
| According to the App you just viewed, when is the | ○ | ○ | ○ | ○ | ○ |

| | Very | 4 | 3 | 2 | Not |
|---|---|---|---|---|---|
| How important is it for you to know the number of | ○ | ○ | ○ | ○ | ○ |

| | Very | 2 | 3 | 4 | Not |
|---|---|---|---|---|---|
| How would you rate the quality of the speaker's | ○ | ○ | ○ | ○ | ○ |
| voice? | ○ | ○ | ○ | ○ | ○ |

| | Very | 2 | 3 | 4 | Not |
|---|---|---|---|---|---|
| How helpful was the speaker in conveying this | ○ | ○ | ○ | ○ | ○ |
| information about the number of seconds remaining? | ○ | ○ | ○ | ○ | ○ |
| How helpful were the visual images in | ○ | ○ | ○ | ○ | ○ |

Please provide any addition feedback you believe would be helpful concerning the quality of the app.

Please indicate your response to the following items concerning earthquake safety and behavior based on the video you just viewed.

| | | | | | |
|---|---|---|---|---|---|
| I would immediately look at my phone upon receiving the warning I justheard. | ○ | ○ | ○ | ○ | ○ |
| I would immediately try to call or text a friend after receiving the earthquake warning I just heard. | ○ | ○ | ○ | ○ | ○ |
| I would immediately try to call or text a loved one after receiving this earthquakewarning. | ○ | ○ | ○ | ○ | ○ |
| I would attempt to seek out more information after receiving thiswarning. | ○ | ○ | ○ | ○ | ○ |
| I would drop upon receiving an earthquake warning for severe shaking. | ○ | ○ | ○ | ○ | ○ |
| I would take cover upon receiving an earthquake warning for severe shaking. | ○ | ○ | ○ | ○ | ○ |
| I would hold on to something stable upon receiving an earthquake warning for severeshaking. | ○ | ○ | ○ | ○ | ○ |
| I would take no action after receiving an earthquake warning for severeshaking. | ○ | ○ | ○ | ○ | ○ |
| If this app were available, how likely are you to download it? | ○ | ○ | ○ | ○ | ○ |

Please indicate your response to the following items concerning earthquake safety and behavior.

| | | | | | |
|---|---|---|---|---|---|
| When strong shaking begins, I believe I can master the skills to protect myself from an earthquake. | | | | | |
| I believe I can take appropriate action after receiving a warning to protect myself during an earthquake. | ○ | ○ | ○ | ○ | ○ |
| After the onset of strong shaking, dropping to the ground is one thing I can do to protectmyself. | | | | | |
| I know I can take action to protect myself from an ea | ○ | ○ | ○ | ○ | ○ |
| When strong shaking begins, covering myself is one thing I can do to protectmyself. | | | | | |
| I believe I have the ability to take the necessary action to protect myself from anearthquake. | ○ | ○ | ○ | ○ | ○ |
| I don't believe that I have the skills to protect myself from an earthquake. | | | | | |
| I know that I have the ability to do things to protect myself in the event of anearthquake. | ○ | ○ | ○ | ○ | ○ |
| What I do with the knowledge I have about earthquakes will help keep me safe. | | | | | |
| Nothing I can do will protect me during an earthquake. | ○ | ○ | ○ | ○ | ○ |
| | ○ | ○ | ○ | ○ | ○ |
| | ○ | ○ | ○ | ○ | ○ |
| | ○ | ○ | ○ | ○ | ○ |
| | ○ | ○ | ○ | ○ | ○ |
| | ○ | ○ | ○ | ○ | ○ |

The next questions deal with your perceptions of the United States Geological Survey (USGS).

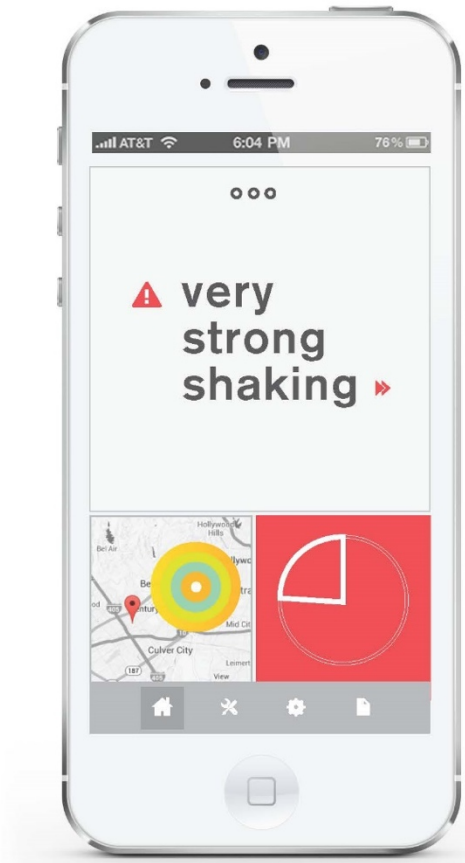
| | **Not confident** | **Not** | | |
|---|---|---|---|---|
| How confident are you that the USGS can respond | ○ | ○ | ○ | ○ |
| effectively to protect thepublic? | ○ | ○ | ○ | ○ |
| How confident are you that the USGS will respond fairly to your needs, regardless of your race, ethnicity, income or other personal characteristics? | ○ | ○ | ○ | ○ |
| How confident are you that the USGS will provide honest information to the public? | ○ | ○ | ○ | ○ |

t

Please indicate your level of agreement with the following statements regarding earthquake preparedness.

| | | | | | |
|---|---|---|---|---|---|
| I have an operating flashlight. | | | | | |
| I have extra batteries for the flashlight. | | | | | |
| I own a battery operated radio. | | | | | |
| I know the radio frequency of the National Oceanic and Atmospheric Association (NOAA) all hazards broadcast. | | | | | |
| I have extra batteries for the radio. | | | | | |
| I have at least 4 gallons of potable water stored in plastic containers. | | | | | |
| I have at least a 4 day supply of non-perishable food for my household. | | | | | |
| I have an operating fire extinguisher. | | | | | |
| I have a wrench to operate utility shut off valves and switches. | | | | | |
| I know the location of my water shut off valve. | | | | | |
| I have a complete first-aid kit. | | | | | |
| I know the location of my gas shut off valve. | | | | | |
| I know the location of my electric power shut off valve. | | | | | |
| I know how to operate my water shut off valve. | | | | | |
| I know how to operate my gas shut off valve. | | | | | |
| I know how to operate my electric power shut off valve. | | | | | |
| My cabinets are securely fastened with latches. | | | | | |
| My water heater is securely fastened to the wall. | | | | | |
| The tall furniture in my home is fastened to the wall. | | | | | |

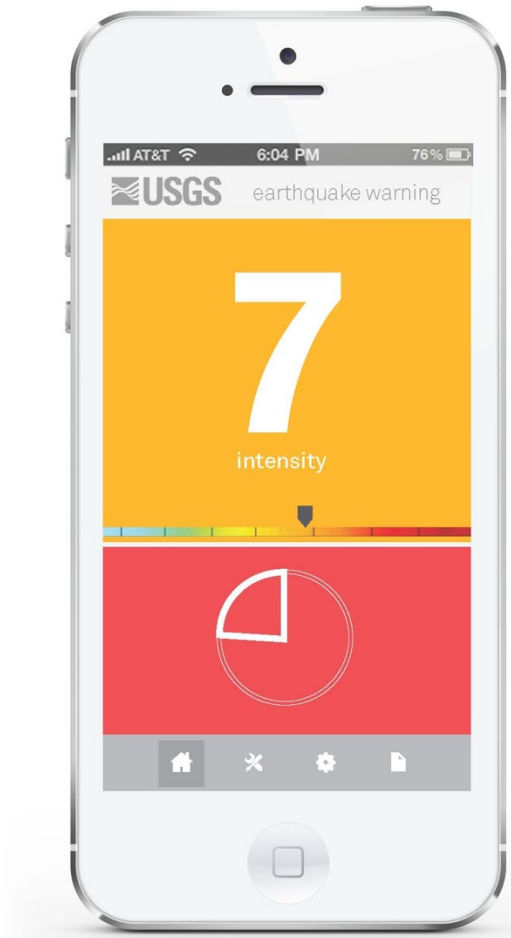
## Appendix C: Treatment Conditions




USGS Earthquake Early Warning App Variations — 2

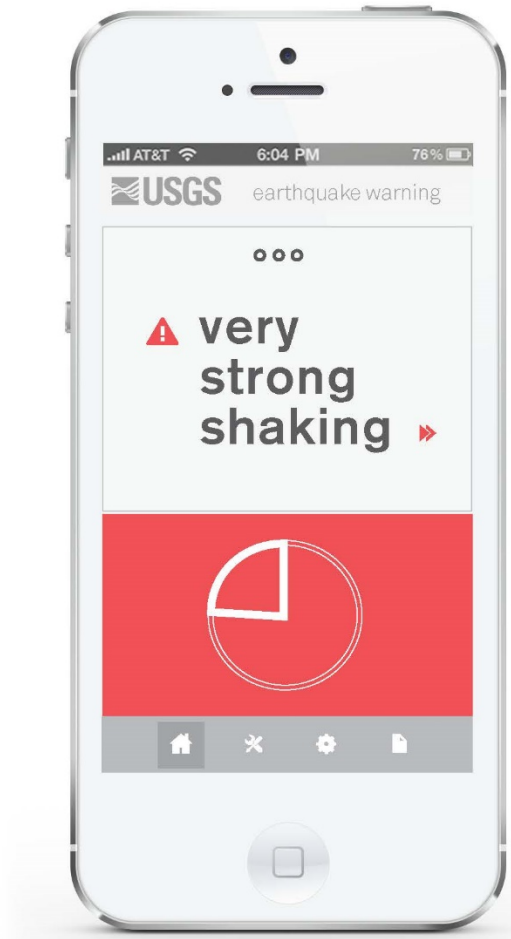
# VARIATION 1

× graphic countdown
× map included
× intensity non-numerical



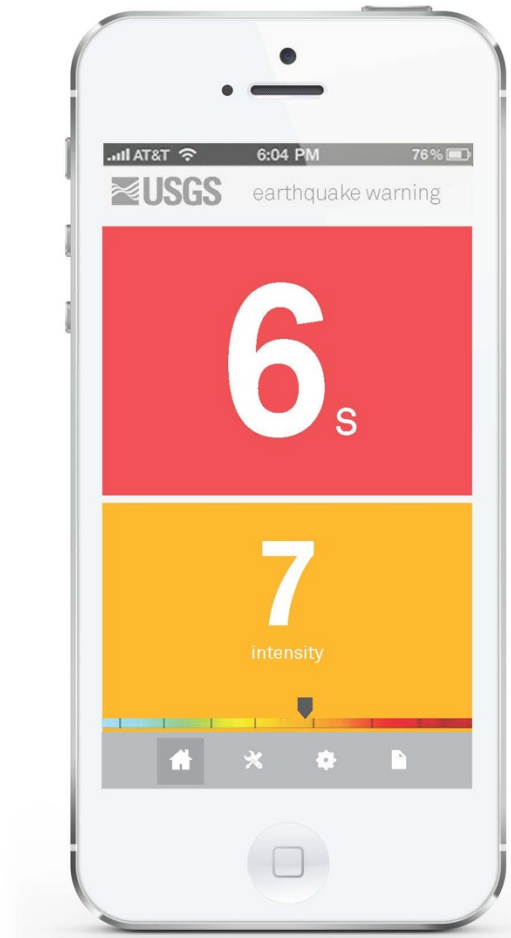

# VARIATION 3

× graphic countdown
× no map
× intensity numerical



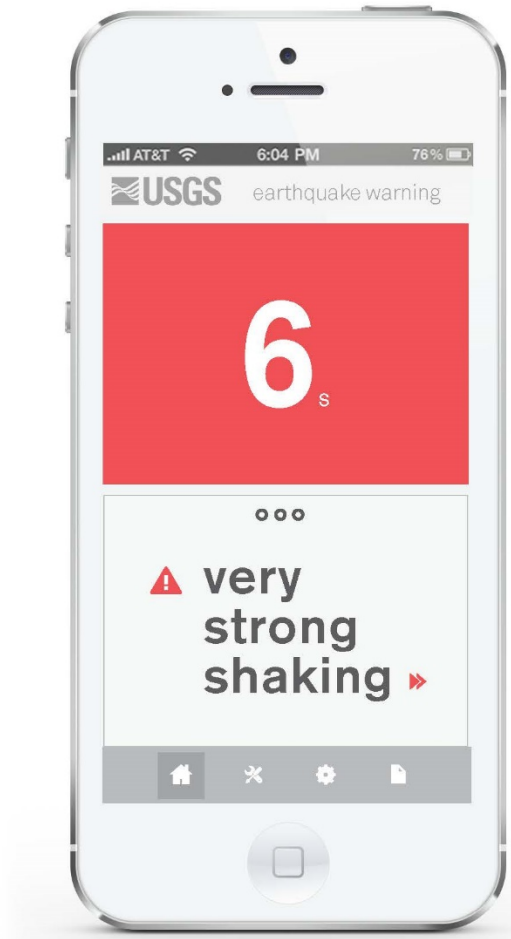

# VARIATION 5

× graphic countdown
× no map
× intensity non-numerical




# VARIATION 6

× numerical countdown
× no map
× intensity numerical




# VARIATION 8

× numerical countdown
× no map
× intensity non-numerical

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**Conference Proceedings**

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Ivanov, B., Parker, K., Vos, S., **Haarstad, N.,** & Geegan, S. (2014). *Beyond simple inoculation: Examining the persuasive value of inoculation for audiences with initially neutral or negative attitudes.* Paper presented at the 100th Annual Convention of the National Communication Association, Chicago, IL.

Hinderaker, A. N., **Haarstad, N.**, Bill, T. J., Johnson, J. D., & Delzer, M. (2013). *Making connections between forensics praxis and the communication discipline: A panel discussion.* Symposium presented at the 99th Annual Convention of the National
Communication Association, Washington, DC.

Wilson, B., Young, L., & **Haarstad, N.** (2013). *Communication, knowledge capture, management, and transfer: An examination of a failed MOOC.* Paper presented at the Kentucky Communication Association annual conference, Carrolton, KY.

**Haarstad, N.,** Holbrook, D., Jones, A., Schartel, S., & Schultz, J. (2011, November). In A. Hinderaker (Chair), *Graduate student directed forensics programs: A panel discussion on maintaining team voice without faculty position support.* Panel

conducted at the meeting of the National Communication Association, New Orleans, LA.

**Haarstad, N.** (2010, September). *Metaphorical Enthymeme: A rhetorical criticism of "Barack Obama: Son of Promise, Child of Hope."* Paper presented at the annual conference of the Communication, Speech & Theatre Association of North Dakota, Bismarck, ND.

**Haarstad, N.** & Hinderaker, A. (2009, September). *Making conflict rhetoric mainstream: The DeclareYourself.org public service announcements.* Paper presented at the annual conference of the Communication, Speech & Theatre Association of North Dakota, Bismarck. ND.