Summer 2015

Tornado Trouble: How Can Current Tornado Warnings be Improved?

Jonathan P. Evans

TORNADO TROUBLE: HOW CAN CURRENT TORNADO WARNINGS BE IMPROVED?

by
JONATHAN P. EVANS
(Under the Direction of Lawrence Locker)

ABSTRACT

There are many unnecessary deaths from tornadoes every year (NOAA.org, 2013). Although there have been great advancements in tornado warning systems (Coleman, Knupp, Spann, Elliot, & Peters, 2010), more changes to systems could be made to motivate people to take action in preparation for tornadoes (Brotzge & Donner, 2013). Protection motivation theory outlines the process by which we assess threats and decide whether or not preventative actions are worth performing. If the threat is perceived as severe enough and the preventative actions are seen as capable of mitigating the threat, the individual is motivated to act (Rogers, 2000). One means by which to enhance the efficacy of weather warnings is through the use of visual imagery. Research has shown that pictures are more easily remembered than words (e.g., Jenkins, Neale & Deno, 1967), and that the addition of picture descriptions or "pictorials" to public safety warnings increases the comprehension and perceptions of risks (Wogalter & Laughery 1997; Severson & Henriques, 2009 respectively). However, the effect of pictures varies depending on many factors including how closely the pictures are perceptually linked to the text and how the picture relates to the target audience (Houts, Doak, Doak, & Loscalzo, 2006). In the current study, we examined the influence of visual imagery in the context of tornado warnings. Specifically, we examined the effects of different tornado warnings on perceptions of susceptibility, response efficacy, and self-efficacy. The warnings varied by whether or not they contained pictures of damage, pictures of preparations, or no pictures. The pictures also varied by tornado category (F2 or F4). F4 warnings were expected to elicit greater susceptibility than F2 warnings. Warnings with pictures of damage were expected to elicit higher susceptibility in an interactive effect in the context of F4 warnings than those with preparation or no pictures. Warnings with preparation pictures were expected to elicit greater levels of efficacy than those with damage or no pictures. Warnings with either type of picture were expected to elicit higher levels of comprehension. The results revealed that participants who viewed the F4 warnings perceived themselves to be more at risk than those who viewed the F2 warnings. There was an effect of both damage and preparation pictures on response efficacy of actions recommended in the event of a tornado, such that those who viewed warnings with either type of picture rated the recommended actions as more efficacious that those who simply saw a text warning. Also, in this study a trend was observed such that participants who viewed more severe tornado warnings (i.e., F4) rated themselves as more efficacious (self-efficacy) in the event of a tornado than those who viewed less severe tornado warnings (i.e., F2). Also of importance, those who viewed the F4 warnings had overall lower comprehension of damage or susceptibility related information when compared to those who viewed F2 warnings. Implications of results and future directions are discussed.

INDEX WORDS: Risk perception, efficacy, pictorial effects

TORNADO TROUBLE: HOW CAN CURRENT TORNADO WARNINGS BE IMPROVED?

by

JONATHAN P. EVANS

B.S., Columbus State University, 2011

A Thesis Submitted to the Graduate Faculty of Georgia Southern University in Partial

Fulfillment

of the Requirements for the Degree

MASTER OF SCIENCE

STATESBORO, GEORGIA

2015

TORNADO TROUBLE: HOW CAN CURRENT TORNADO WARNINGS BE IMPROVED?

by

JONATHAN EVANS

B.S., Columbus State University, 2011

Major Professor: Lawrence Locker , Jr.

Committee: Karen Z. Naufel

Ty W. Boyer

Electronic Version Approved:
Summer 2015

ACKNOWLEDGMENTS

I would like to thank my committee chair, Lawrence Locker, for the substantial and prudent attention he has paid to my thesis work and the significant amount of comments and help with the study design afforded by the members of my thesis committee, Karen Naufel and Ty Boyer. I would also like to thank Mark Welford for his assistance with the study design. Finally, I would like to thank the many research assistants for their aid in collecting data for this study.

TABLE OF CONTENTS

Page

ACKNOWLEDGEMENTS.......... 6

LIST OF TABLES.......... 7

CHAPTER

1 INTRODUCTION.......... 9

2 METHOD.......... 21

Analyses and Results.......... 24

3 DISCUSSION.......... 28

REFERENCES.......... 31

APPENDICES

A TEXT ONLY WARNING STIMULI 35

B SUSCEPTIBILITY MEASURE.......... 36

C SELF-EFFICACY MEASURE.......... 37

D RESPONSE EFFICACY (ACTIONS).......... 38

E RESPONSE EFFICACY (KIT) 39

F DEMOGRAPHICS 41

G COMPREHENSION.......... 43

LIST OF FIGURES AND TABLES

Page

Figure 1 – Mean Susceptibility (Picture Condition).. 45

Figure 2 – Mean Susceptibility (Tornado Type)... 45

Figure 3 – Mean Response Efficacy (Actions) for Picture Condition....................................... 46

Figure 4 – Mean Response Efficacy (Kit) for Picture Condition.. 46

Figure 5 – Self-Efficacy for Picture Condition.. 47

Figure 6 – Self-Efficacy for Tornado Type.. 47

Figure 7 – Mean Comprehension for Picture Condition... 48

Figure 8 – Mean Comprehension for Tornado Type... 48

Table 1 - Frequency Table Showing Gender.. 49

Table 2 - Frequency Table Showing Age... 50

Table 3 - Frequency Table Showing Race/Ethnicity... 51

Table 4 – Frequency Table Showing Education Level.. 52

Table 5 – Frequency Table for Answers to "How likely do you think it is that a tornado will strike in Statesboro?"... 53

Table 6 – Frequency Table for Answers to "How likely do you think it is that you will ever experience a tornado?".. 54

Table 7 – Frequency Table for Answers to "Do you currently live in a mobile home?"............ 55

Table 8 – Frequency Table for Answers to "Have you ever been in a tornado before?"............ 56

Table 9 – Frequency Table for Answers to "When you were in the tornado, how prepared did you feel?"... 57

Table 10 – Frequency Table for Answers to "Are you familiar with the Enhanced Fujita (F-scale) Scale for Tornado Damage?"... 58

Table 11 – Frequency Table for Answers to "What response options do you have available in the event of a tornado strike?"... 59

Tornado Trouble: How can current tornado warnings be improved?

The number of tornadoes in the United States averages 818 per year, resulting in 77 deaths on average per year with 54 deaths in 2013 (NOAA.org, 2013). The susceptibility (i.e., risk) due to tornadoes cannot be overstated. For example, in Alabama and the surrounding states in 2011, 324 fatalities were caused by a three-day tornado outbreak (NOAA.org, 2013). One critical factor contributing to susceptibility from tornadoes is lack of preparedness (Balluz, Schieve, Holmes, Kiezak, & Malilay, 2000; Brotzge et al., 2013; Coleman, Knupp, Spann, Elliot, & Peters, 2010). For example, on March 1st, 1997 only 47.4% of people responded to a warning of a tornado outbreak in Arkansas that involved the loss of several lives (Balluz et al., 2000). Although there have been substantial advancements in warning systems, the statistics cited previously indicate that further modifications of warnings may be needed, particularly in terms identifying factors that might further influence people's motivation to take action to prepare for tornadoes (Brotzge et al. 2013; Coleman, Knupp, Spann, Elliot, & Peters, 2010).

History of Tornado Warnings

Research concerning communication of the event of an expected tornado began in the late 19th century, with the first warning system comprised of telegraph lines that were designed to break in the event of strong winds, indicating the possibility of a tornado strike. However, it was not until March 1948, with the advent of weather radar and storm prediction networks that the first tornado warning with predicted expected damage and length of the tornado outbreak was issued by U.S. Air Force forecasters. This warning saved many lives and prevented the loss of thousands of dollars in damage, although, no specific statistics were given for specific quantities related to this event (Coleman, Knupp, Spann, Elliot, & Peters, 2010). Current tornado warnings issued by the National Weather Service (NWS) continue to provide warnings concerning tornado characteristics (e.g., severity) as well as actions that are recommended to prevent harm. However, despite these warnings, challenges remain concerning means by which to motivate people to properly prepare for what may be perceived to be a rare event or one that may never be experienced (Doswell, Moller & Brooks, 1998).

Signal Detection and Error Management Theory

Error management theory (EMT), based on the earlier proposed signal detection theory (SDT), states that we have a cognitive bias to act as if there were a threat in an ambiguous situation even though there may not be a threat present (see Macmillan, 2002 for a review). EMT assumes that one must perceive a threat as harmful and the costs of responding to said threat as fruitful (e.g., acting as if the threat is present and as if a response will prevent the negative consequences of the perceived threat) before one decides to take action to prevent or avoid the harmful effects of the threat. Humans exhibit behavioral and cognitive biases under conditions of uncertainty, such that a threat is perceived as more harmful than it may actually be to avoid unnecessary (and potentially harmful) mistakes in judgment (Johnson, Blumstein, Fowler & Haselston, 2013). Accordingly, the previously cited study references the design of smoke alarms, which offer an example of EMT by implementing a “better safe-than-sorry” strategy. These alarms are set to go off with even a small detection of smoke (e.g., when one burns food in the oven; a false positive error according to EMT and SDT), consequently minimizing error in detecting the threat of an actual fire (i.e., minimizing the possibility of a miss). To provide an example in human behavior, people are likely to check both ways before crossing a street even if we have no immediate evidence that a car is or is not coming, reflecting the tendency to avoid what is known as a false negative event (i.e., an event in which a threat is not detected when it is actually occurring). By checking both ways before we cross, we are making certain that we do not walk out in front of a vehicle that was not originally perceived as being a threat to our health (Johnson et al., 2013). EMT aligns fairly well with Protection Motivation Theory (PMT) in that we assess the probability of being affected by the threat, as well as the cost of acting to protect ourselves from a threat, before we decide how we should act in the face of the threat. EMT states that we have a bias to act as if a threat will harm us even when there is no threat present, because the cost of acting in preparation (e.g., checking to see if a car is coming before crossing a street) is less costly than the disaster that may occur if we don't act in preparation (e.g., walking across the street without checking to see if a car is coming before crossing). However, EMT does not take in to account all necessary response provoking characteristics in a threat-inducing situation. PMT extends EMT in that it takes into account one's perceived severity of a threat, one's susceptibility of being affected by a threat, one's own efficacy for dealing with the consequences of a threat, and the perceived efficacy of recommended preventative behaviors in the face of a threat. Although PMT will be the main framework used to interpret the study's results, some of the results to follow can be interpreted with more ease in the context of EMT.

Protection Motivation Theory

Protection motivation theory (PMT) of persuasive communication (Rogers, 2000) states that deciding whether or not the actions are worth performing in response to a threat is governed by a process of assessing both the severity of the threat and our susceptibility of being affected by the threat. A response also is influenced by the perceived efficacy of recommended actions used to mitigate the threat's effects (response efficacy), the ability to carry out said actions (self-efficacy) as well as the perceived cost of carrying out the recommended actions. Therefore, PMT provides a particularly useful framework within which to further investigate perceptions of weather warnings particularly in terms of how warnings can be more efficacious in conveying both risk and action information.

PMT can be broken down into two processes: threat appraisal and coping appraisal (Rogers, 2000). These two processes were partly based upon the fear appeal research of Lazarus (1991) and the fear communications research of Leventhal (1967; 1970). Leventhal's (1967) research was the first of its kind to assess the perceptions of susceptibility and self-efficacy in communications that are meant to motivate individuals to act in the face of danger. According to the research of Rogers and colleagues, during threat appraisal the individual assesses both the severity of a threat and vulnerability of being affected by the threat. During coping appraisal the individual assesses the effectiveness of recommended actions used to remove or prevent possible harm from the threat (i.e., response efficacy), and the individual's ability to carry out said actions in the event of the threat (i.e., self-efficacy), based on their past evaluation of severity and susceptibility. Individuals also take into account the cost of carrying out the recommended actions before deciding to act in response to the threat (Rogers, 2000). Importantly, if the perceived susceptibility of being affected by a threat outweighs the perceived effectiveness of the recommended behaviors and the ability to perform said behaviors, one is less motivated to act in response to the threat, at least in the context of the recommended actions. Conversely, if one perceives that carrying out recommended preventative or protective behaviors will significantly mitigate the effects of a threat in a low cost to benefit ratio, then one's motivation to utilize said actions is increased. However, one must not only feel some sense of susceptibility from the threat, but must also feel as if they are able to mitigate the threat with the recommended actions before they ultimately decide to act.

PMT has been used as a theoretical framework in a variety of contexts including predicting environmental conservation efforts (Kantola, Syme, & Nesdale, 1983), developing cognitive models of health and exercise behavior (Maddux, 1993), and producing materials to help explain the use of medical aid devices (see Floyd, Prentice-Dunn, & Rogers, 1997; Melamed, Rabinowitz, Feiner, Weisberg, & Ribak, 1996 and Milne, Sheeran, & Orbell, 2000 for reviews of the literature). Of particular relevance to the study is that PMT has also been used to provide a model for prediction of behaviors in the context of threat regarding weather preparation, such as earthquakes (Mulilis & Lippa, 1990). Mulilis and Lippa (1990) gave participants an assessment of earthquake preparedness behavior. Participants were then presented with a negative threat-inducing message about earthquakes and earthquake preparedness meant to manipulate "their beliefs along four dimensions: subjective probability of a large earthquake, expected severity of earthquake damage, perceived effectiveness of earthquake preparedness, and perceived capability of preparedness for earthquakes." (p.625). These four dimensions were intended to align with PMT in that they reflected susceptibility (probability and severity), response efficacy (preparedness), and self-efficacy (capability of preparedness). Participants returned after a five-week period and were given the same assessment. Comparison of participants' pre and post measures revealed that the intervening message led to a significant change in participants' responses concerning earthquake preparedness on all the dimensions listed above. Specifically, perceived probability and severity were heightened after the presentation of the threat-inducing message and perceived preparedness and capability were lower after the presentation of the message. The authors theorized that since the threat inducing messages were created to correspond to the four foundational dimensions of PMT, the message was more effective in regard to conveying severity, and consequently the participants perceived themselves to be more at risk of being affected by the earthquake. The researchers also concluded that since they did not include positive messages regarding preparedness for earthquakes in the message, the participant's efficacy decreased. The authors further concluded that, in the context of PMT, positive preparedness messages should be included in messages since individuals are more motivated to act to prepare when they perceive the threat, even if the threat severe. This research suggests that preparedness could be increased even more via the use of more positive messages regarding efficacy of preventative behaviors.

The current study extends PMT to the context of understanding perceptions of tornado warnings, specifically in terms of perceived susceptibility, response efficacy, and self-efficacy - as these factors, according to PMT, are integral to the extent to which a message leads an individual to prepare or act. As current weather warnings do currently convey relevant information concerning both risk and action the importance to explore means by which to make the information more effective (e.g., facilitating attention or comprehension) increases. Although not extensively studied in the context of weather warnings, visual imagery has been shown to be a viable means by which to facilitate the communication and understanding of information including perception of risk and response behavior, in a number of domains (e.g., Young & Wogalter, 1988; Severtson & Henriques, 2009; see also Houts, Doak, Doak, & Loscalz, 2006 for a review concerning the use of visual imagery in the context of health related information).

Pictorial Effects in the Literature

Visual imagery has been linked to enhanced memory of information, comprehension, and attention (e.g., Kirkpatrick, 1894, Shepard, 1967, Hockley, 2008, and Hockley & Bancroft 2011, Houts, et al. 2006). For example, the *picture superiority effect* refers to the finding that memory is better for pictures relative to words of the same concept (e.g., Kirkpatrick, 1894, Shepard, 1967, Hockley, 2008, and Hockley & Bancroft 2011). The picture superiority effect has been attributed to the notion that visual imagery provides richer or more robust information compared to verbal information during encoding, and therefore, it is easier to retrieve information encoded visually compared to verbally (e.g., Shepard, 1967).

One theoretical framework which picture superiority effects have been accounted for is Paivio's (e.g., 1969; 1971; 1986) *dual-coding theory*. Dual-coding theory suggests that there are two separate cognitive memory systems that we use to process verbal and visual information. The verbal and visual mental codes to which these concepts correspond can be used to think about, store and retrieve the information for later use (Paivio 1969; 1971; 1986; see also Sternberg, 2003 for a review). Paivo (1969) found that participants who were shown a sequence of pictures exhibited better recall for the concepts relative to participants who were shown the same concepts in verbal form. Paivio's explanation for the better recall of concepts in pictures over words was that pictures are coded dually and the availability of multiple codes in memory leads to a greater likelihood of retrieval. Specifically, when a visual image is coded, a verbal label is activated with the corresponding image, whereas a word is encoded only verbally. The dual visual and verbal codes lead to a greater probability of retrieval relative to a single verbal code (Paivio, 1969; see also Sternberg, 2003).

McBride and Dosher (2002), alternatively, postulate that pictures prompt a deeper level of cognitive processing than words in conceptual tasks. The researchers presented participants with both words and pictures for various items. Each item was presented for 3500 milliseconds in a random order and, after the complete series was presented, participants were asked either to recall as many of the words and pictures as they could, or generate novel responses. Novel responses were defined as words and pictures with which participants were not presented at the beginning of the session, but were generated independently by the participant during the recall session and were related in some way to the concepts presented beforehand. Although recall for words and pictures was similar, items presented as pictures were better able to illicit novel responses, leading the researchers to believe that information in the pictures was processed "deeper" or more thoroughly in memory than the words viewed before recall. Their reasoning was that pictures provide more information for the participants to process than words, and this helped them generate more novel responses as a result (McBride & Dosher , 2002). The authors state that these results reflect that viewing pictures allows for "deeper" processing than reading words, for two reasons. First, the results align with Paivo's (1969; 1971; 1986) dual coding theory in that pictures provide multiple codes for processing, while words only provide a single code for processing. Second, the authors also state that pictures may lead to deeper conceptual processing than words for the recall tasks due to the fact that pictures directly activate a concept, while words elicit meaning indirectly via phonetic representation.

The cognitive benefit of pictures is also evidenced by the utility of visual information in applied areas. In the health domain, the use of pictorials has been shown to facilitate comprehension, recall, attention, and adherence to information in health safety (e.g., warning labels on machinery) and health information materials (e.g., procedures for self-care once a patient leaves the hospital). However, the effectiveness of visual information could depend upon how it is presented. (Houts et al. 2006). Although the effectiveness of the picture can depend upon such factors as differences in complexity of the picture or the use of drawings versus photographs, the literature clearly shows that the addition of picture descriptions or "pictorials" to public safety warnings can enhance the comprehension and perception of susceptibility, as well as increase the prevalence of the use recommended behavioral interventions designed to mitigate the effects of a health susceptibility (Houts et al., 2006; , Severtson & Henriques, 2009; Wogalter & Laughery 1997; Young & Wogalter, 1988). Young and Wogalter (1988) gave participants instructional manual warnings with conspicuous text (large with highlighting compared to the rest of the manual) or plain text (same as rest of manual) accompanied or unaccompanied with pictorials related to the warning (e.g., a drawing of a hand being shocked in an electrocution warning). Their results revealed that participants who viewed the warnings with both the conspicuous text and pictorials were better able to recall the warning content and meaning of the of the warnings easier than those who viewed any other variation of the manuals.

Severtson and Henriques (2009) presented participants with hypothetical drinking water test results in either an alphanumeric or one of two graphical formats (both with pictures) showing contamination levels in the water. The two graphical formats that were presented were similar to each other. One format contained more detail by providing a graded scale image while the other format contained a plain scale image with less detail. Both images were associated with the risk in drinking water that contained high levels of contaminant. Participants were given various measures including one assessing motivation to stop drinking water from the tested source, since the hypothetical test results indicated contaminants in the water. Participants who received the test results with graphics and pictures were more motivated to mitigate the risk of drinking contaminated water by stopping consumption of the water. Additionally, the group who received the plain graphic with a non-graded image was the most motivated to stop drinking the water at the recommended cutoff point showing that the simpler image conveyed information in a more useful and straightforward manner. From these results it was inferred that the participants who viewed the water test results with less detailed graphics and pictures comprehended the risk of drinking contaminated water better than those in the groups who viewed the results without graphics or with more detail graphics (Severtson & Henriques, 2009). From the descriptions of the studies above, the benefit of adding pictures to health warnings and other materials can be clearly seen.

Pilot Data and the Current Study

Naufel, Locker, Evans, and Losee and Welford (2014) examined the effect of visual imagery on the perception of weather warnings. The images used in this study were actual pictures of damage that reflect the severity of the storm for which warning is being conveyed. Warnings were manipulated in level of intensity (F2 vs F3 vs F4) and whether or not the warning contained visual imagery. The National Weather Service currently groups tornadoes into categories (F1 through F5) depending on the wind speeds of the tornadoes. All warnings included text and audio similar to what is shown on television in the United States. In the visual condition, pictures accompanied the text and audio whereas the non-visual condition was text and audio only. Outcome measures included measures of comprehension of information presented in the warning (i.e., tornado characteristics, expected damage), the perceived efficacy of actions recommended by NOAA (National Oceanic and Atmospheric Association) in the event of a tornado, perceived efficacy of a tornado emergency kit recommended by NOAA, perceived efficacy of the participant to carry out these actions and put together a kit, as well as the perceived susceptibility or risk of being affected by the tornado strike. The picture manipulation had an effect on susceptibility in that susceptibility was higher for the picture condition. This effect is thought to be present because of the increase in salience of information regarding damage through the addition of damage pictures. Due to the increase in salience, participants who viewed the warnings with pictures feel more susceptible. Additionally, susceptibility was higher for warnings of tornados with greater severity such that F3 tornado warnings elicited scores of higher susceptibility than F2 tornado warnings and F4 tornado warnings elicited scores of higher susceptibility than F3 tornado warnings. There was also an interaction of the pictures and tornado category level, which indicates that susceptibility was highest for the F4 warning with visual imagery condition. No effect of the pictures or tornado category was observed on either the comprehension and efficacy measures.

Although the inclusions of pictures did affect perception of susceptibility, pictures did not appear to influence comprehension nor measures of efficacy. However, imagery included only pictures of damage, and therefore may have provided no influence on efficacy either positively or negatively. That is, there is a possibility that there could be a negative effect of the damage pictures on efficacy. It is possible that perceptions of efficacy would be lowered due to the enhanced perception of risk, but as noted, no effects of picture condition or tornado category on efficacy were observed. Therefore, the current study replicated the findings concerning the effect of pictures of damage on perceptions of susceptibility and further explored the effect of visual imagery on perceptions self-and-response efficacy by including pictures of preparation. It was predicted that pictures of preparation for a tornado strike would increase perceptions of response efficacy and self-efficacy, whereas pictures of damage will increase perceptions of susceptibility. Furthermore, it was predicted that the extent to which pictures influence responding may vary as a function of the level of severity of the tornado, where pictures of damage would be expected to have a greater impact for severe storms, whereas pictures of preparation would have a greater influence for less severe storms. In terms of PMT, those who rate themselves as more susceptible (i.e., those who view the warnings with damage pictures) to the storm are therefore expected to report that they feel less able to personally prepare (i.e., self-efficacy) for the tornado than those who view the preparation or text and audio only warnings whereas those who view the warnings with preparation pictures would be expected to report that they feel more able to personally prepare the tornado than those who view the damage and text and audio warnings. The extent to which this varies as a function of tornado category will be examined. By extension, PMT predicts that responding would be a function of the relative perception of both efficacy and risk. Consequently, the outcome measures examined in the current study should provide insight into the types of information that might most effectively lead, if applied in a real-world context, to a response. In the context of PMT, responses reflecting both higher perceptions of efficacy and risk are related to a higher likelihood of responding in the context of an actual tornado warning.

Method

Participants

170 (110 females; 60 males) participants participated in the study. Participants were Georgia Southern Students recruited via the online experiment management system (SONA) and received course credit or extra credit for participation. The mean age of the participants was 19.83 (*SD* = 2.90).

Design and Materials

The study is a 2 (Tornado Category) x 3 (Picture Condition) between- subjects design. Participants were randomly assigned to one of the six conditions. Participants were presented with either an F2 or F4 category tornado text as well as a voice warning. The text and voice aspects of the warning included all information pertaining to the category of the warning (F2 or F4), the area expected to be effected by the warning (i.e., Bulloch county), and the expected time that the tornado is expected to occur in this area. The voice and text warnings were accompanied by either pictures of damage following a storm (i.e., pictures reflecting damage from the respective tornado categories), pictures of people preparing for the storm (e.g., people entering an underground shelter), or no pictures at all. There was a scrolling text line in the middle of the text only warnings or above the pictures for warnings including pictures that communicates the tornado category, the counties for which the warning is being conveyed (in this case Bulloch County), and the time in which the tornado is expected to take place. The voice aspect of the warnings included all information mentioned above that is included in the text of the warnings as well as described expected damage to homes, apartment buildings, and large institutions (e.g., schools or universities) and expected wind speeds for the particular category of tornado. The voice dimension also communicated call to action statements (e.g., “If no underground shelter is available go to an interior room on the lowest floor…”). Call to action statements were taken from a publication by Troutman, Richard, and Mark (n.d.) on the NOAA website. Warnings (i.e., text and voice aspects) were designed to match tornado warnings disseminated by the National Weather Service of the United States and pictures were selected so that they reflected the local architecture and landscape of the local area (see Houts et al. 2006, who suggest that matching a picture to the local culture increases the effectiveness of the use of pictures in health communications). The pictures are the only part of the warning that is added on to the design of warnings currently disseminated by NOAA. Pictures were obtained online using degree of damage descriptors for varying levels of tornado intensities from the NOAA website (NOAA.org) and were public domain. Screen shot stills of text and voice warnings and a description of picture warnings are included in Appendix A. Three pictures reflecting damage consistent with damage descriptions from NOAA for the F2 and F4 damage condition warnings, are rotated through by fading one in and one out as the video progresses for each tornado category warning (F2 and F4). Similarly, three pictures of people preparing for a tornado, reflecting response and self-efficacy, are presented by fading one in and one out while the video plays. The same preparation pictures are shown in both the F2 and F4 warning that contain preparation pictures. Participants viewed the tornado warnings and then completed all outcome and demographic questions on Qualtrics survey software in a designated lab in the Georgia Southern University psychology department. Responses were recorded by the software ready for download into an SPSS file for later analyses.

Measures

Following the tornado warning, each participant was presented measures consisting of comprehension questions about the tornado category, expected damage, and expected wind speeds of the tornado described in the warning (Appendix G)[1]. Participants also completed four scales adapted from Miller, Adame, and Moore's (2013) work with Vested Interest Theory and preparedness for disasters. These scales are intended to measure the perceived susceptibility of being affected by the tornado in the warning (see Appendix B), perceived ability to prepare for a tornado (i.e., Self-Efficacy, see Appendix C), and the perceived efficacy of actions recommended in the warning (i.e., Response Efficacy). The Response Efficacy Measure consists of two subscales: One scale pertains to recommended actions (e.g., How effective are these actions at minimizing the negative consequences of tornado strikes?), and the other concerns a recommended emergency kit [e.g., How effective is an emergency kit minimizing the negative consequences of tornado strikes? (see Appendices D & E)]. A description of the recommended actions and emergency kit to be utilized in the event of a tornado strike were presented directly before the respective scale. Following completion of the aforementioned measures, demographics were collected regarding age, race and gender (see Appendix F for questions and Tables 1 through 11 the frequency of answers for each question).

Procedure

The study was conducted in groups of up to four participants at a time. Each participant viewed the weather warning and completed all measures on a computer. Each computer in the lab was preloaded with the survey and equipped with headphones. The participant first read an informed consent document presented on Qualtrics that listed all of the participant's rights and privileges. If the participant agreed to continue, they clicked "yes" at the bottom right corner of

---

[1] Unfortunately, two questions about the voiceover call to action (CTA) statements included in all of the tornado warnings (i.e., "If no underground shelter is available…go to an interior room on the lowest floor… mobile homes and vehicles are not safe," see Appendix D for the comprehension questions) that were intended to be included in the comprehension questions were not due to a possible software error when updating the comprehension questions from the pilot study. Therefore, comprehension questions reflected the susceptibility aspects as in the pilot study.

screen. If the participant chose "no", the survey closed out and a screen thanked them for coming to the lab.

After providing consent, participants were told that they would view a video and answer questions about the video. They then placed the headphones on and Qualtrics randomly selected one of the six tornado warning conditions. Following the video, participants then completed the outcome measures described above followed by the demographics questions. The order of presentation of the measures of susceptibility and efficacy were randomized to avoid order effects (Perdue & Summers, 1986). After the participants complete the measures they were debriefed and thanked for their participation in the study.

Analyses and Results

Susceptibility

A 2 x 3 (tornado type x picture condition) Analysis of Variance (ANOVA) was conducted to assess the effect of the independent variables on susceptibility. Two participants did not respond to the susceptibility measure and therefore this analysis was based on $N = 168$. It was predicted that the group who viewed the warnings with damage pictures would respond as being more susceptible relative to the preparation and text and voice only conditions and that the group that viewed warnings with preparation pictures would respond as being less susceptible relative to the damage and text and voice only conditions. These predictions were not supported. There was no effect of picture type on susceptibility, F (2, 162) = .37, p >.05, η_p^2= .005 (see Figure 1).

Additionally, it was predicted that those who view the F4 warnings would rate themselves as more susceptible than those who view the F2 warnings as seen in the pilot study. This prediction was supported. The was a significant effect of warning category type, F (1, 162) = 7.55, p = .007, η_p^2= .045, such that participants who viewed the F4 warnings perceived themselves as being more susceptible to being negatively affected by the tornado than did those who viewed the F2 warnings (see Figure 2). There was no interaction of tornado type and picture condition on susceptibility, F (2, 162) = 1.57 $p > .05$, $\eta_p^2 = .019$.

<u>Response Efficacy and Self-Efficacy</u>

A 2 x 3 (tornado type x picture condition) Multivariate Analysis of Variance (MANOVA) was conducted to test the effect of pictures and tornado type on the measures of response efficacy (kit and actions). Nine participants did not respond to the response efficacy measures and therefore this analysis was based $N = 161$. It was predicted that participants who viewed the warning with pictures of preparation would rate the recommended kit and actions as more effective than those who view warnings with text and voice only or pictures of damage on both of the response efficacy measures. There was a significant multivariate effect of picture type on the efficacy of recommended actions, Wilks' $\Lambda = .936$, F (4,308) = 2.60, $p < .05$, $\eta_p^2 = .033$. There was no effect of tornado category, Wilks' $\Lambda = .37$, F (2, 154) = .80, $p > .05$, $\eta_p^2 = .005$, nor an interaction, Wilks' $\Lambda = .995$, F (4, 308) = .80, $p > .05$, $\eta_p^2 = .010$. A univariate ANOVA for the main effect of picture condition revealed a significant difference between conditions for the efficacy of the recommended actions variable (i.e., response efficacy action measure), F (2, 155) = 3.55, $p < .05$, $\eta_p^2 = .044$. Fisher's least significant difference (LSD) test revealed that there was a significant difference for scores on this particular response efficacy scale between the participants who viewed the warnings with damage pictures and those who viewed warnings with no pictures ($p = .036$) as well as a significant difference between the participants who viewed the warnings with preparation pictures and those who viewed warnings with no pictures ($p = .016$) such that those who viewed warnings with any type of picture scored higher on the scale measuring response efficacy of actions. There was no difference between those who viewed warnings with damage pictures and those who view warnings with preparation pictures ($p > .05$) (see Figure 3). The univariate ANOVA for the response-kit variable only trended toward significance, F (2, 155) = 2.61, $p = .08$, $\eta_p^2 = .033$. Fisher's LSD test was used to compare the effect of picture condition on scores on the response efficacy of the recommended emergency kit. The participants who viewed warnings including damage pictures perceived the emergency kit as more efficacious that those who viewed warnings with no pictures at all ($p = .02$). However, there was no significant difference for scores on this particular response efficacy scale between the participants who viewed the warnings with preparation pictures and those who view warnings with no pictures ($p > .05$). Also, there was no difference between those who viewed warnings with damage pictures and those who viewed warnings with preparation pictures ($p > .05$) (see Figure 4). However, as noted, given that the univariate ANOVA testing the effects of the IVs on the response efficacy of the emergency kit was not significant, this trend should interpreted cautiously.

A 2 x 3 (tornado type x picture condition) Analysis of Variance (ANOVA) was conducted to assess the effect of the independent variables on self-efficacy. Five participants did not respond to the response efficacy measures and therefore this analysis was based $N = 165$. It was predicted that participants who viewed the warning with pictures of preparation would rate themselves as better able to respond appropriately (i.e., self-efficacy) than those who view the other warning types (i.e., text and voice only and damage pictures) to a tornado strike. This prediction was not confirmed. There was not a significant effect of picture type on perceptions of self-efficacy, F (2,159) = 1.40, $p > .05$, $\eta_p^2 = .017$ (see Figure 5). It was also predicted that the participants who viewed the F2 warnings would be more likely to rate themselves as more able to prepare for a tornado strike than those who viewed the F4 warning. This prediction was not supported. There was not a significant effect of warning type on perceptions of self-efficacy, F (1,159) = 3.14, p = .078, η_p^2= .019 (see Figure 6). Rather, the trend in the data was such that those who saw the F4 warnings perceived themselves as more able to prepare (i.e., self efficacy) for the tornado than those who saw the F2 warnings. There was no interaction between picture condition and condition and tornado category, F (2, 159) = 1.31, $p > .05$, η_p^2= .016.

Comprehension

A 2 x 3 (tornado type x picture condition) Analysis of Variance (ANOVA) was conducted to test the effect of pictures and tornado type on the measures of comprehension. Although we did not find differences on the comprehension measure in the pilot study, it was predicted that if an effect were found, we would have expected a main effect of picture type. That is, if visual imagery facilitates cognitive processing (e.g., attention or memory), then participants would be expected to show higher comprehension in the picture conditions relative to the text and voice only condition. This was not the case, however. There was not a significant effect of picture type on comprehension, F (2, 164) = .86, $p > .05$, η_p^2= .007 (see Figure 7). There was, however, a significant effect of warning category on comprehension, F (1,164) = 22.82, $p < .001$, η_p^2= .122 such that participants who viewed the F2 warnings scored significantly higher on the comprehension questions than those who viewed the F4 warnings (see Figure 8). There was no interaction between tornado type and picture condition on comprehension, F (2,164) = 1.43, $p > .05$, η_p^2= .017.

Discussion

The results revealed that participants who viewed the F4 warnings perceived themselves to be more at risk than those who viewed the F2 warnings, replicating the results found in the pilot study. It is important to note, however, that in the current study there was no effect of damage pictures on perceptions of susceptibility as was seen the pilot study. Rather, there was an effect of both damage and preparation pictures on response efficacy of actions recommended in the event of a tornado such that those who viewed warnings with either type of picture rated the recommended actions as more efficacious than those who simply saw a text warning. Also, in this study a trend was observed in that self-efficacy differed to some extent by tornado category such that those who viewed more severe tornado warnings (i.e., F4) tended to rate themselves as more efficacious in the event of a tornado than those who viewed less severe tornado warnings (i.e., F2). One possible explanation for the differences between the current study and the pilot study is that, in the pilot study, only damage or susceptibility related information was included in warnings (i.e., CTA statements were not included in pilot study voiceovers). Therefore it is possible that, in the pilot study, this lead to an emphasis on processing of susceptibility related information, whereas, in the current study, CTA statements were included in the voice over of the warnings which could contribute to processing of efficacy information in addition to risk information across all warnings.

Interestingly, those who viewed the F4 warnings had overall lower comprehension of damage or susceptibility related information when compared to those who viewed F2 warnings. Although speculative, it may be that this is reflective of attention, for those who viewed the F4 warnings, being directed away from the risk information in favor of efficacy related information. This may also account for the trend in the data regarding tornado category and self-efficacy in that although participants significantly perceived greater risk for the F4 warnings, there was a trend toward greater self-efficacy for the more severe category.

In the context of EMT, if there is a bias towards minimizing risk (i.e., avoiding a miss) it may be beneficial to not focus attention primarily on the more severe aspects of a threat such that attentional resources and potential action planning can be devoted to efficacy related information, particularly if the severity is already very evident. That is, since the participants are overloaded with threatening or susceptibility related information in all F4 warnings, their attention is turned to means to mitigate the effects of the threat (i.e., the recommended actions noted in the voice aspect of the warning) rather than devoting attention to the threat aspect. Furthermore, this appears to be facilitated by the inclusion of visual imagery as would be predicted based on prior literature suggesting the processing advantages associated with visual imagery (e.g., Paivio, 1986; McBride & Dosher, 2002). However, contrary to the predictions, both types of pictures contributed to a greater focus or perception of efficacious actions, possibly via deeper processing concerning the overall message being presented. Indeed, if the current interpretation is accurate, it would follow that even pictures of damage would lead to more attention to the efficacy aspect as evidenced by the aforementioned comprehension difference and trend concerning self-efficacy between tornado categories.

Given the results of the pilot study it should be emphasized that responding, at least in the context of the two studies, appears to be driven strongly by the information presented. That is, even if participants may adopt a strategy emphasizing the processing of efficacy-related information, this information must be present in the warning. This is critical in the context of PMT in that a response is based on both the perceived risk and success of actions to avoid the risk. These results suggest that, in terms of responding, it is critical to include information related to both aspects, not simply emphasize the aspect of risk. Rather a warning should emphasize the seriousness of a given situation while at the same time ensuring that response-related information is included. It should be noted that participants did attend to the differences in susceptibility between tornado categories in the expected direction in both studies (i.e., risk was higher for F4 than F2). The inclusion of visual information also had an effect in both studies, but again the effect of imagery may be a function of the information contained in the warning (i.e., risk only versus risk and efficacy information). The two studies would seem to align with PMT in that participants weighed both risk and efficacy information and, if our interpretation is correct, may even attend more so to efficacy-related information in a compensatory fashion as risk increases. However, further research is needed to empirically test these ideas.

In terms of limitations, this study may need to be replicated in areas of more frequent tornadoes to test the effect of pictures in the context of tornado warnings on populations with more tornado experience. This study was conducted with college students in a region with less frequent tornadoes although some tornadoes are experienced in the area. Second, the effects of pictures in warnings should eventually be tested in actual warnings in the field to assess their influence on actually eliciting action to prepare for tornadoes outside of a laboratory setting. As the study was conducted in a laboratory, the responses are a function of perceived risk and efficacy and consequently, although likelihood of responding can be extrapolated in the context of PMT or EMT, actual responding was not examined. However, this study contributes to the growing literature examining assessing the factors that affect motivation in response to a threat, specifically tornado warnings, in a controlled setting.

References

Balluz, L., Schieve, L., Holmes, T., Kiezak, S. and Malilay, J. (2000). Predictors for People's Response to a Tornado Warning: Arkansas, 1 March 1997. *Disaster,* 24(1), 71-77.

Brotzge, J., and Donner, W. (2013). The Tornado Warning Process: A Review of Current Research, Challenges, and Opportunities. *Bull. Amer. Meteor. Soc.*, 94, 1715–1733.

Coleman, T. A., Knupp, K. R., Spann, J., Elliott, J. B., & Peters, B. E. (2010). The history (and future) of tornado warning dissemination in the United States, *Bulletin of the American Meteorological Society,* 567-582.

Doswell, C., Moller, A., & Brooks, H.,(1998). Storm Spotting and Public Awareness Since the First Tornado Forecasts of 1948. *Weather and Forcasting*, *14*, 544-557.

Houts, P.S., Doak, C.C., Doak, L.G., Loscalzo, M.J. 2006. The role of pictures in improving health communication: A review of research on attention, comprehension, recall, and adherence. *Patient Education and Counseling* 61, 173-190.

Jenkins, J. R., Neale, D. C., & Deno, S. L. (1967). Differential memory For Picture and word stimuli. Journal of Educational Psychology, 58, 303-307.

Johnson, D., Blumstein, D., Fowler, J., & Haselton, M. (2013). The evolution of error: Error management, cognitive constraints, and adaptive decision-making biases. *Trends in Ecology & Evolution, 28*(8), 474-481.

Kantola, S. J., Syme, G. J., & Nesdale, A. R. (1983). The effects of appraised severity and efficacy in promoting water conservation: An informational analysis. *Journal of Applied Social Psychology*, 13, 164-182.

Kirkpatrick, E.A. (1894). An experimental study of memory. *Psychological Review, 1,* 602-609.

Lazarus, R. S. (1991). Emotion and Adaptation, New York: Oxford University Press.

Leventhal, H., Watts, J. C. and Pagano, F. (1967). Effects of Fear and Instructions of How to Cope with Danger. *Journal of Personality and Social Psychology*, 6(3), 313-321.

Leventhal, H. (1970). Findings and theory in the study of fear communications. In L. Berkowitz (Ed.)*, Advances in experimental social psychology* 5, pp. 119-186). New York, NY: Academic.

Macmillan, N.A. (2002) Signal Detection Theory. In H. Pashler and J. Wixted (Eds.), *Stevens' Handbook of Experimental Psychology, Volume 4: Methodology in Experimental Psychology* (pp. 43-90) Retrieved from http://www.researchgate.net/profile/George_Gescheider/publication/19876984_Psychophysical_scaling/links/00b4952b8987b6ebb0000000.pdf#page=55.

Mcbride, D., & Dosher, B. (2002). A comparison of conscious and automatic memory processes for picture and word stimuli: A process dissociation analysis. *Consciousness and Cognition, 11*, 423-460. Retrieved November 6, 2014, from http://www.socsci.uci.edu/maplab/webdocs/concog2002.pdf

Miller, C. H., Adame, B. J., & Moore, S. D. (2013). Vested interest theory and disaster preparedness. *Disasters, 37,* doi: 10.1111/j.1467-7717.2012.01290.x

Milne, S., Sheeran, P., & Orbell, S. (2000). Prediction and intervention in health-related behavior: A meta-analytic review of protection motivation theory. *Journal of Applied Social Psychology.* 30(1) 106-143

Mulilis, J. P., & Lippa, R. (1990). Behavior changes in earthquake preparedness due to negative threat appeals: A test of protection motivation theory. *Journal of Applied*

Social Psychology, 20,619-638.

Naufel, K.Z., Locker, L., Evans, P., Losee, J. (2014, April) Perceptions of Weather: Tornado Warnings and Visual Imagery. Paper presented at the Georgia Southern University Research Symposium, Statesboro, GA.

NOAA, 2013. Retrieved from: http://www.spc.noaa.gov/.

Paivio, A (1969). Mental Imagery in associative learning and memory. *Psychological Review*, 76(3), 241-263.

Paivio, A (1971). *Imagery and verbal processes*. New York: Holt, Rinehart, and Winston.

Paivio, A (1986). *Mental representations: a dual coding approach*. Oxford. England: Oxford University Press.

Perdue, B. C., & Summers, J. O. (1986). Checking the success of manipulations in marketing experiments. *Journal of Marketing Research*, *23*, 317-326.

Rogers, R. W. (2000). A Meta-Analysis Of Research On Protection Motivation Theory. *Journal of Applied Social Psychology*, *30*, 407-429.

Severtson, D.J. and Henriques, J.B. (2009). The effect of graphics on environmental health risk beliefs. emotions, behavioral intentions, and recall. *Risk Analysis*, 29, 1549-1565.

Shepard R N, 1967 Recognition memory for words, sentences and pictures. *Journal of Verbal Learning and Verbal Behaviour,* 6, 156-163.

Sternberg, R. J. (2003). *Cognitive theory* (3rd ed.). Belmont, CA: Thomson Wadsworth.

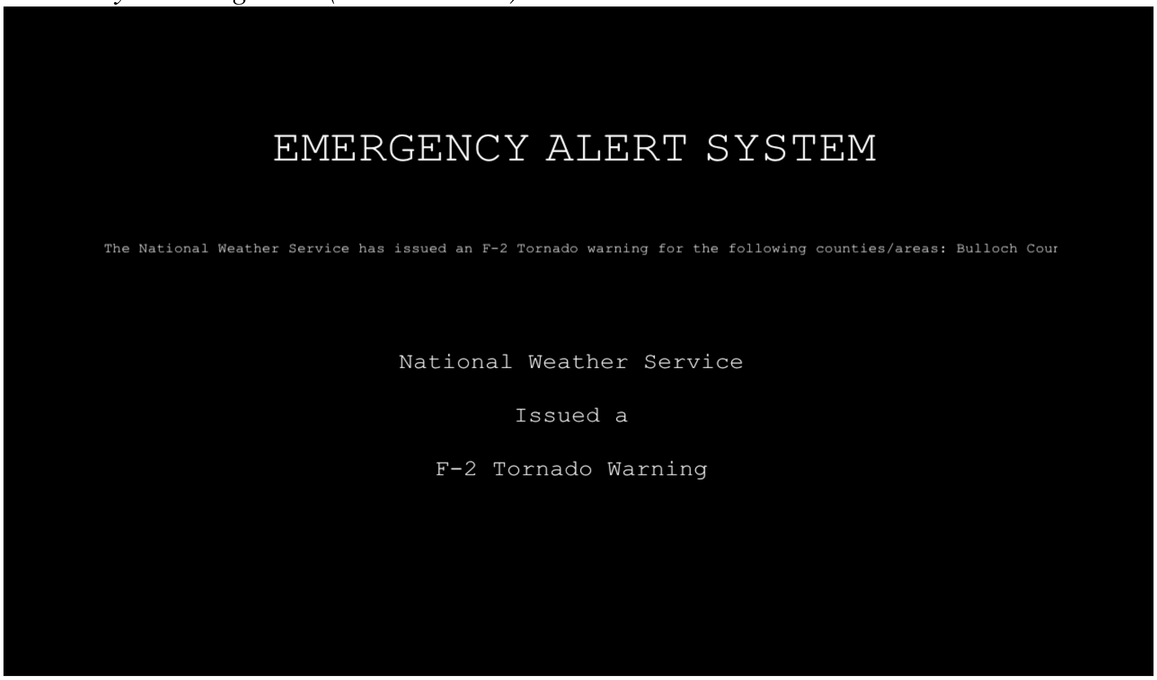
Troutman, T., Richard, S., & Mark, R. (n.d.). Situation Specific Call-To-Action Statements. Retrieved April 3, 2014, from http://www.srh.noaa.gov/ssd/techmemo/sr215.htm.

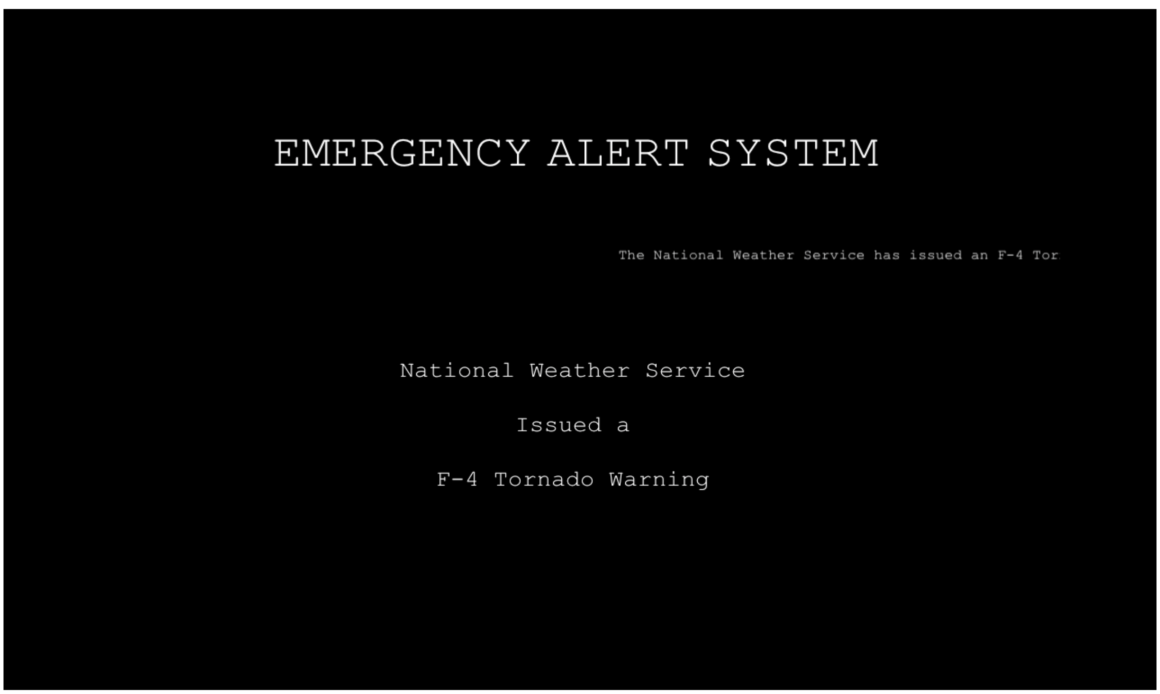
Wogalter, M.S. and Laughery, K.R. 1996. WARNING! Sign and Label Effectiveness. *Psychological Science,* 5, 33-37.

Young, S. L., & Wogalter, M. S. (1988). Memory of instruction manual warnings: Effects of pictorial icons and conspicuous print. *Proceedings of the Human Factors Society*, *32*, 905-909.

Appendix A

Text Only Warning Stills (include voice)





Note: Warnings with damage or preparation pictures included pictures in addition to the information seen in the warnings above. Pictures were included in between the scrolling text and "National Weather Service" line that reflect the damage (if damage condition) of the particular tornado in the warning or simply show people preparing for tornados.

Appendix B
Susceptibility Measure

Consider the weather warning you just saw. Imagine that was a real warning issued for Statesboro. How susceptible are you to THAT tornado's effect. Susceptibility is defined as being vulnerable to harm or at risk for a particular threat. Please answer these questions as best as you can

1. How susceptible are you to getting injured by this tornado?

Not Susceptible 1 2 3 4 5 6 7 Highly Susceptible

2. How susceptible is your property to getting damaged by this tornado?

Not Susceptible 1 2 3 4 5 6 7 Highly Susceptible

3. What is the possibility your property will get damaged by this tornado?

Not Possible 1 2 3 4 5 6 7 Highly Possible

4. How at risk is your community of getting hit by this tornado?

Not at Risk 1 2 3 4 5 6 7 Highly at Risk

5. Given that you live in Georgia, what is your risk of getting hit by a tornado?

No Risk 1 2 3 4 5 6 7 High Risk

Appendix C

Self-Efficacy Measure

Please use the information provided in the video to respond to the following questions.

1. How capable are you at effectively preparing to help respond to a tornado strike?

   Not Capable 1 2 3 4 5 6 7 Highly Capable

2. How able are you to take the time to prepare in the event of a tornado strike?

   Not Able 1 2 3 4 5 6 7 Highly Able

3. How easy would it be for you to prepare for a tornado strike?

   Not Easy 1 2 3 4 5 6 7 Very Easy

4. How much knowledge do you have about preparing in response to a tornado?

   No Knowledge 1 2 3 4 5 6 7 Great Knowledge

5. How effective are you at preparing in the event of a tornado strike?'

   Not Effective 1 2 3 4 5 6 7 Highly Effective

Appendix D
Response Efficacy (Actions)

The National Oceanic and Atmospheric Association recommends the following if a tornado is coming:

- Avoid windows.
- Get in the basement and under some kind of sturdy protection (heavy table or work bench), or cover yourself with a mattress or sleeping bag
- Know where very heavy objects rest on the floor above (pianos, refrigerators, waterbeds, etc.) and do not go under them. They may fall down through a weakened floor and crush you.
- Head protection, such as a helmet, can offer some protection also.

Please answer the following questions regarding how effective these strategies would be at protecting you in the event the tornado came.

1. How effective are these actions at minimizing the negative consequences of tornado strikes?

   Not Effective 1 2 3 4 5 6 7 Highly Effective

2. How effective would these actions be in reducing the damage caused by a tornado?

   Not Effective 1 2 3 4 5 6 7 Highly Effective

3. How effective will these actions be at lowering distress following a tornado strike?

   Not Effective 1 2 3 4 5 6 7 Highly Effective

4. How effective will these actions be at minimizing damage from a tornado to your property or belongings?

   Not Effective 1 2 3 4 5 6 7 Highly Effective

5. How effective are these actions at reducing the impact of tornadoes?

   Not Effective 1 2 3 4 5 6 7 Highly Effective

Appendix E
Response Efficacy (Kit)

The following questions ask about response efficacy. Response efficacy is defined as the ability of a tool or procedure to produce a desired result.

The National Oceanic and Atmospheric Association recommends all Georgia residents have an Emergency Supply Kit. This supply kit contains a three-day supply of water, non-perishable food, radio, first aid kit, matches, etc.

Please answer the following questions regarding how effective various related responses may be to the tornado strike.

1. How effective is an emergency kit in minimizing the negative consequences of tornado strikes?

Not Effective 1 2 3 4 5 6 7 Highly Effective

2. How effective would an emergency kit be in reducing the damage caused by a tornado?

Not Effective 1 2 3 4 5 6 7 Highly Effective

3. How effective do you think an emergency kit will be at lowering distress following a tornado strike?

Not Effective 1 2 3 4 5 6 7 Highly Effective

4, How effective is an emergency kit at minimizing damage from a tornado to your property or belongings?

Not Effective 1 2 3 4 5 6 7 Highly Effective

5. How effective is an emergency kit at reducing the impact of tornadoes?

Not effective 1 2 3 4 5 6 7 Highly Effective

6. How effective is planning ahead of time at reducing the potential harm caused by tornadoes?

Not effective 1 2 3 4 5 6 7 Highly Effective

7. How effective are emergency alert radio messages at helping respond to a tornado strike?

Not effective 1 2 3 4 5 6 7 Highly Effective

Appendix F

Demographics

1 What is your gender?

- Male
- Female

2. What is your age? (in years)

[----]

3. What is your race/ethnicity? (Check all that apply)

- African American
- Asian
- Caucasian
- Hispanic
- Native American
- Pacific Islander
- Other (not listed)
- I prefer not to respond

4. What is your education level?

- First year student
- Sophomore
- Junior
- Senior

5. How likely do you think it is that a tornado will strike in Statesboro?

Likert Scale [Very Unlikely ------------------- Very Likely]

6. How likely do you think it is that you will ever experience a tornado?

Likert Scale [Very Unlikely ------------------- Very Likely]

7. Do you currently live in a mobile home?

- Yes
- No

8. Have you ever been in a tornado before?

- Yes

- No

If yes to item 8 go to item 9 and then the following questions, if no skip item 9 and go to following questions.

9. When you were in the tornado, how prepared did you feel?

Likert Scale [Not at all prepared ------------------- Very Prepared]

10. Are you familiar with the Enhanced Fujita (F-scale) Scale for Tornado Damage?

- Yes
- No

11. What response options do you have available in the event of a tornado strike? (Select all that apply)

- Underground Shelter
- Basement/Lower Floor
- Interior room without windows

Appendix G

Comprehension Questions

The following questions are asking you about the weather warning you just viewed. Please answer these questions as best as you can.

1. According to the warning, what category was the tornado?

- F-1
- F-2
- F-3
- F-4
- F-5

2. What was the expected wind speed associated with the tornado?

- 55
- 81
- 113
- 142
- 171

3. According to the warning, what is the expected damage to the home?

- Some visible damage
- Broken glass in doors and windows
- Collapsing of some walls
- Collapsing of all walls
- Home’s slab swept completely clean

4. According to the warning, what is the expected damage to a home's roof?

- No roof damage
- Loss of roof covering material (<20%)
- Uplift of roof deck
- Major roof damage, with part of roof remaining
- Removal of roof
- No roof – Home's slab swept completely clean

5. According to the warning, what is the expected damage to a home's foundation?

- No damage expected
- Home shifts off foundation
- Tearing off of the sides of the home
- Complete destruction of home
- Home's foundation completely wiped clean, and slab carried a few feet

Figure 1
Mean Susceptibility (Picture Condition)

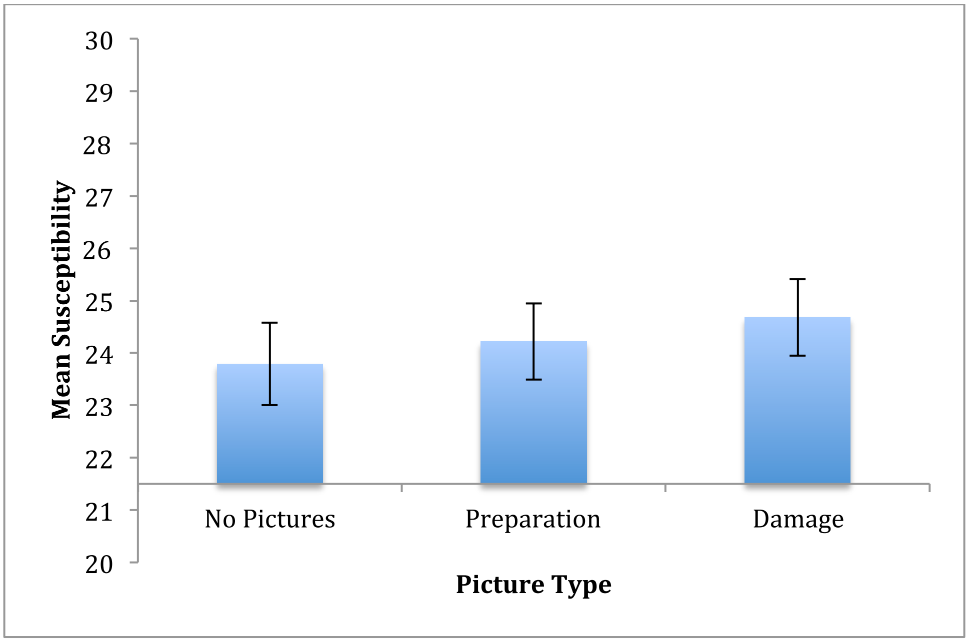


Figure 2
Mean Susceptibility (Tornado Type)

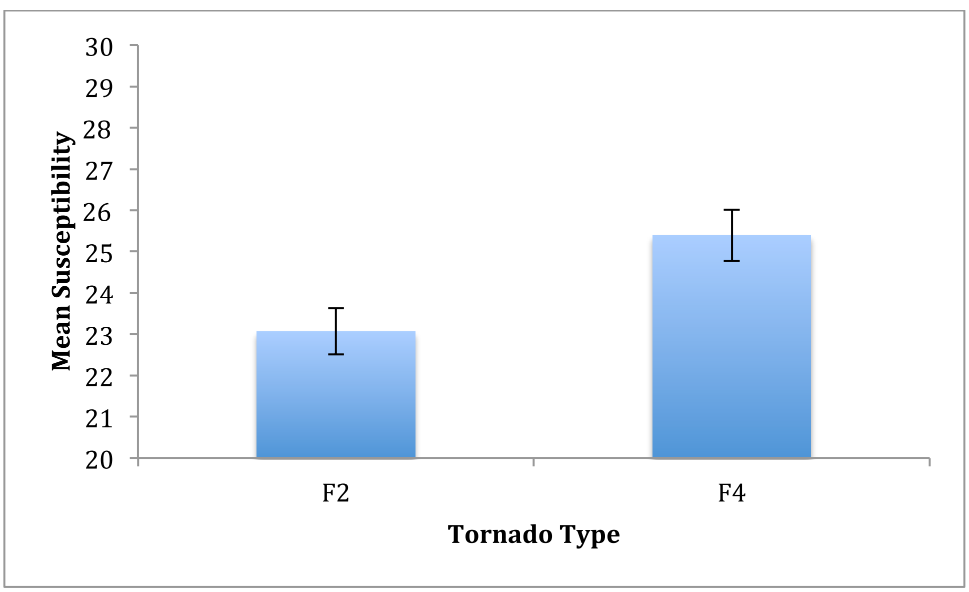


Figure 3

Mean Response Efficacy (Actions) for Picture Condition

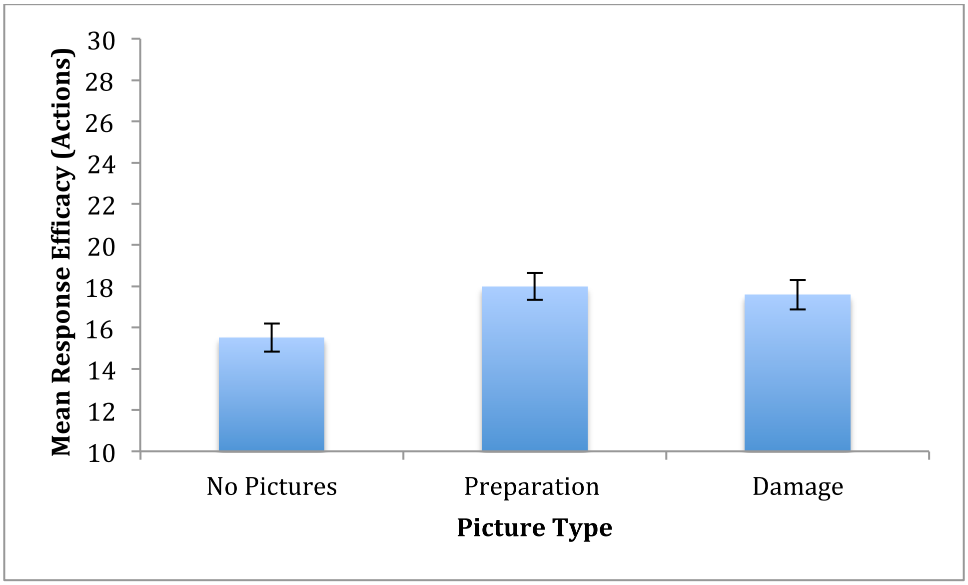


Figure 4

Mean Response Efficacy (Kit) for Picture Condition

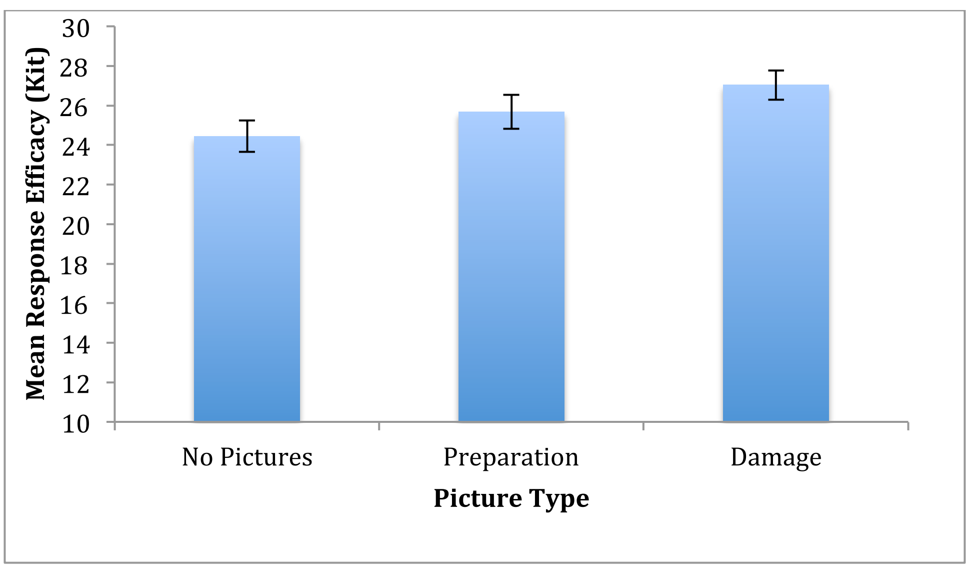


Figure 5
Self-Efficacy for Picture Condition

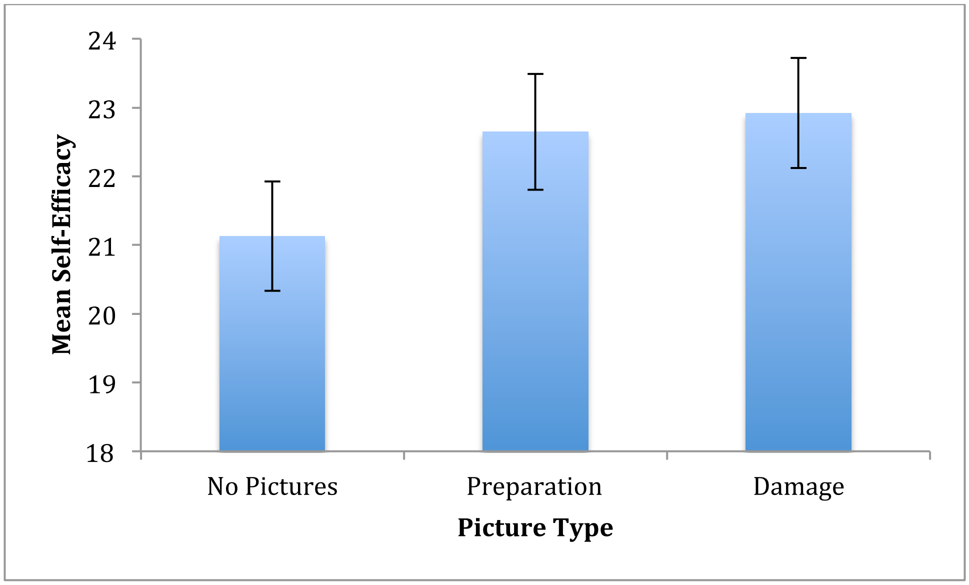


Figure 6
Self-Efficacy for Tornado Type

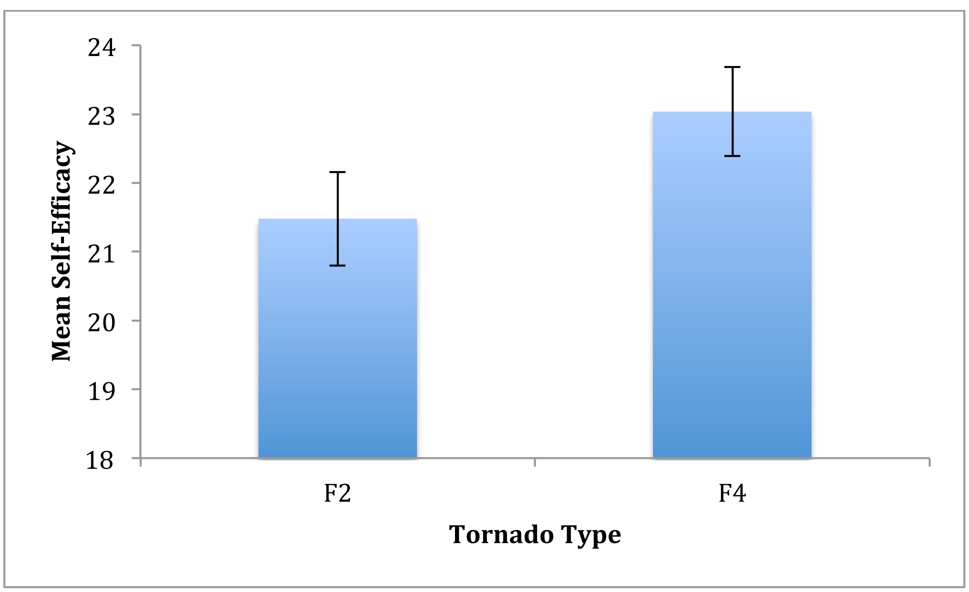


Figure 7
Mean Comprehension for Picture Condition

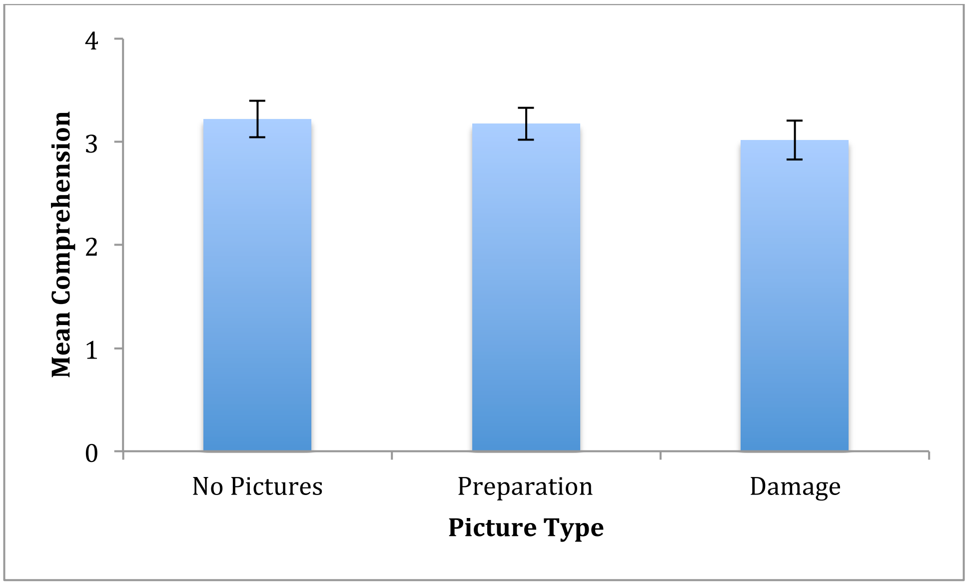


Figure 8
Mean Comprehension for Tornado Type

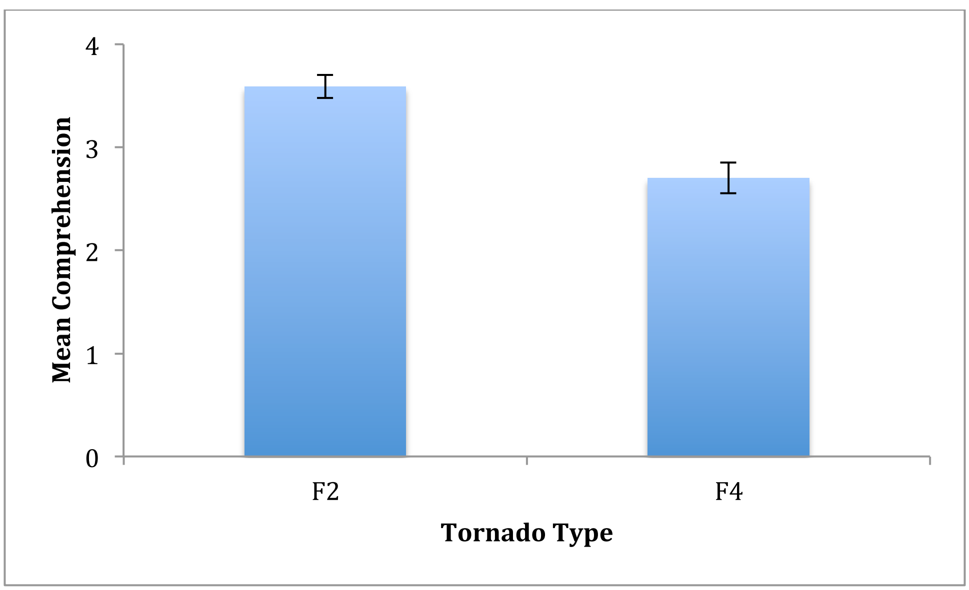


Table 1

Frequency Table Showing Gender

Gender	Frequency	Percent	Valid Percent	Cumulative Percent
Female	110	64.7	64.7	64.7
Male	60	35.3	35.3	100

Table 2
Frequency Table Showing Age

Age	Frequency	Percent	Valid Percent	Cumulative Percent
18	37	21.8	21.8	21.8
19	65	38.2	38.2	60
20	33	19.4	19.4	79.4
21	17	10	10	89.4
22	10	5.9	5.9	95.3
23	1	.6	.6	95.9
24	3	1.8	1.8	97.6
26	1	.6	.6	98.2
28	1	.6	.6	98.8
38	1	.6	.6	99.4
46	1	.6	.6	100

Table 3
Frequency Table Showing Race/Ethnicity

Race	Frequency	Percent	Valid Percent	Cumulative Percent
African American	52	30.6	30.6	30.6
Asian	1	.6	.6	31.2
Caucasian	104	61.2	61.2	92.4
Hispanic	9	5.3	5.3	97.7
Native American	0	0	0	97.7
Pacific Islander	0	0	0	97.7
Other (not listed)	2	1.2	1.2	98.9
I prefer not to respond	2	1.2	1.2	100.1

Note: Final cumulative percent is above 100 due to one participant selecting more than one race/ethnicity option.

Table 4
Frequency Table Showing Education Level

Year in College	Frequency	Percent	Valid Percent	Cumulative Percent
First Year	82	48.2	48.2	48.2
Sophomore	54	31.8	31.8	80
Junior	24	14.1	14.1	94.1
Senior	10	5.9	5.9	100

Table 5
Frequency Table for Answers to "How likely do you think it is that a tornado will strike in Statesboro?"

Selection	Frequency	Percent	Valid Percent	Cumulative Percent
Very Unlikely	21	12.4	12.4	12.4
Unlikely	36	21.2	21.2	33.5
Somewhat Unlikely	49	28.8	28.8	62.4
Undecided	19	11.2	11.2	73.5
Somewhat Likely	40	23.5	23.5	97.1
Likely	4	2.4	2.4	99.4
Very Likely	1	.6	.6	100

Table 6

Frequency Table for Answers to "How likely do you think it is that you will ever experience a tornado?"

Selection	Frequency	Percent	Valid Percent	Cumulative Percent
Very Unlikely	11	6.5	6.5	6.5
Unlikely	16	9.4	9.4	16
Somewhat Unlikely	27	15.9	15.9	32
Undecided	18	10.6	10.6	42.6
Somewhat Likely	54	31.8	31.8	74.6
Likely	29	17.1	17.1	91.7
Very Likely	15	8.2	8.2	100

Table 7

Frequency Table for Answers to "Do you currently live in a mobile home?"

Selection	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	1	.6	.6	.6
No	169	99.4	99.4	100

Table 8
Frequency Table for Answers to "Have you ever been in a tornado before?"

Selection	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	46	27.1	27.1	27.1
No	124	72.9	72.9	100

Table 9

Frequency Table for Answers to "When you were in the tornado, how prepared did you feel?"

Selection	Frequency	Percent	Valid Percent	Cumulative Percent
Not at all prepared	4	2.4	8.7	8.7
2	8	4.7	17.4	26.1
3	14	8.2	30.4	56.5
4	9	5.3	19.6	76.1
5	8	4.7	17.4	93.5
Very prepared	3	1.8	6.5	100

Note: Only participants who answered "Yes" to question 8 were directed to answer question 9. The percent column represents the percent out of 170 and the valid percent represents the percent out of the 46 that answered "Yes" to question 8.

Table 10

Frequency Table for Answers to “Are you familiar with the Enhanced Fujita (F-scale) Scale for Tornado Damage?”

Selection	Frequency	Percent	Valid Percent	Cumulative Percent
Yes	61	35.9	37.4	37.4
No	102	60.0	62.6	100

Note: Seven participants did not answer this question.

Table 11

Frequency Table for Answers to "What response options do you have available in the event of a tornado strike?"

Selection	Frequency	Percent	Valid Percent	Cumulative Percent
Underground Shelter	17	10	10	10
Basement/Lower Floor	83	48.8	48.8	58.8
Interior room without windows	127	74.7	74.7	133.5

Note: Cumulative percent is above 100 due to multiple participants selecting more than one option.