TORNADO WARNING RESPONSE AMONG INTERNATIONAL AND DOMESTIC COLLEGE STUDENTS IN A DYNAMIC TRACKING TASK

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STUDENTS IN A DYNAMIC TRACKING TASK

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Abstract: This research is to investigate Oklahoma State University's (OSU) international and domestic students' tornado information preferences and their choices of protective actions when facing tornado threats. This study utilized the *DynaSearch* program to conduct a computer-based experiment. The program allowed the researcher to examine study participants' tornado information search patterns, risk perception, and their choices of protective action under different forecast advisories in two tornado scenarios (watch and warning). The researcher collected data from 298 students, which consisted of 112 international and 186 domestic students at Oklahoma State University in the Fall semester of 2019. The researcher randomly assigned 58 international students to the watch alert group and 54 international students to the warning alert group. The researcher also randomly assigned 101 U.S. domestic students to the watch alert group and 85 U.S. domestic students to the warning alert group. The assignment to the watch and warning group allowed the researcher to compare the results of different risk perceptions and protective action after viewing the five separate advisories. The results are that international and domestic students have significantly different risk perceptions and protective action choices towards tornadoes and different tornado information preferences. Thus, more customized alert dissemination methods should be utilized for university students as a vulnerable group. In the future, the results of this study not only can contribute to the development of an efficient warning method for university students in the U.S. but also can help emergency managers and meteorologists to make better warning policies.

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INTRODUCTION

According to the National Oceanic Atmospheric Administration (NOAA), a tornado is a fiercely spinning column of air that extends from a thunderstorm and touches the ground,. An average of 1,253 tornadoes hit the United States each year (NOAA, 2020). Tornadoes have long been one of the major environmental threats to the residents in the Southwestern United States, and Oklahoma is located in the center of Tornado Alley where 25% of all tornadoes occur in the U.S. (Figure 1). To respond to tornadoes, the emergency agency must provide quick tornado risk information to the residents in a tornado's path. More importantly, such information should be organized so that people can make quick decisions such as evacuation or moving to a safe place in the house. As Schumann, Ash, and Bowser (2018) indicate, due to the importance of people's visual interpretation of a warning graphic in determining tornado warning response, the development of an effective warning method is required to reduce the casualties of such terrible tornadoes.

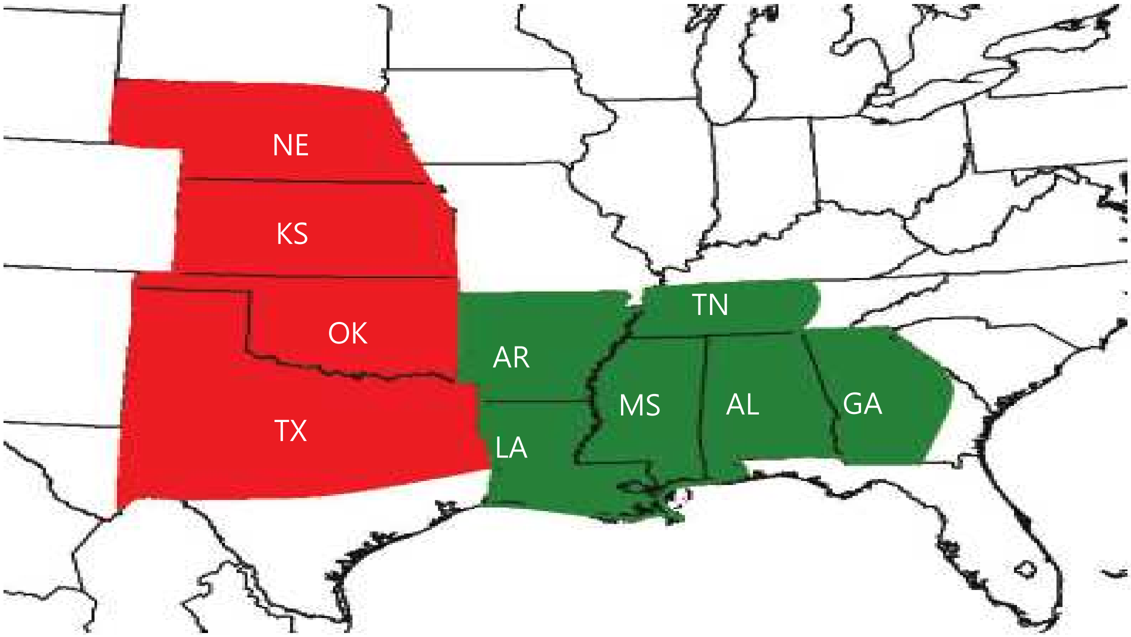


Figure 1. A map outlining the Plains Tornado Alley, in red, and Dixie Tornado Alley in green / Source: revised from Gagan, Gerard, and Gordon (2010)

The U.S. National Weather Services' tornado warnings have been remarkably improved over the past 20 years. Mileti (2004) indicated that in 1978, warnings for 22% of tornadoes were issued, and the average lead time was three minutes. In 1995, the ratio rose to 60% and the lead time increased to almost nine minutes. Today's tornado warnings to the community are significantly different from 20 years ago. One prominent change is the introduction of the tornado polygon as an effective visual warning notice. The tornado polygon is the system in which the tornado-expected area is displayed by its risk area rather than a county boundary. A study shows international and domestic students have different understandings of the warning polygons and they have different preferences of the best protective actions (Jauernic and Broeke, 2017). Furthermore, Jauernic et al. (2017) indicated that few studies show how university students understand and respond to tornado warnings. Accordingly, their safety might be threatened by a scholar's neglect of this issue.

Based on the Protective Action Decision Model, as shown in the following literature review section, this paper aims to examine the relationship between tornado risk information and protective action choices by comparing international and domestic students' tornado risk information search, perceptions and protective action decisions under different tornado scenarios. For this study, instead of the traditional tornado warning/watch polygon, a probabilistic red gradient polygon was used. This is based on Lindell, Jon, and Huang (2018), which suggested that there is little or no difference between probabilistic and deterministic polygon in terms of people's risk perception and protective action decision making. Furthermore, Ash, Schumann, and Bowser (2014) indicated that no one type of polygon design tested in their study was superior to the others in all respects. Instead, the selection of visual warning design assumed several trade-offs. In addition, Miran, Ling, Gerard, and Rothfusz (2018) found that it was the result of information about the closeness to the tornado, and not the probabilistic polygon, that helped people take protective actions. Nevertheless, National Oceanic and Atmospheric Administration (NOAA) have been developing probabilistic forecasting for severe weather such as hurricanes and tornadoes (Lakshmanan, Karstens, Krause, Elmore, Ryzhkov, and Berkseth, 2015; National Hurricane Center, 2014). Thus, it is important to examine the ways in which people perceive these types of warning information.

This study will begin by introducing warning mechanisms and disaster phases. Then, this paper will present four risk and protective action related theories/models, which are an essential process to understand the relationship between warning and protective action decisions. Also, literature about the university student as a vulnerable population will be presented. The next section will thoroughly examine the warning and tornado polygon literature. Using this existing literature review as a guide, the remaining sections of this paper suggests six research questions and 10 research hypotheses related to tornado polygon information and university students' protective action decision when facing tornado threats.

CHAPTER II

LITERATURE REVIEW

2.1. Definition of disaster

Disasters were considered to derive from enormous forces such as ominous arrangements of stars or acts of God. Those theories found a disaster as pre-fixed and, therefore, totally beyond the human's ability to control (Lindell, Prater and Perry, 2006). Quarantelli and Dynes (1970) indicated that disaster was a sponge idea because the word had various meanings over the years. However, there are common meanings that overlap. Perry (2007) indicated that the classical period is from the end of World War II in 1945 to the publication of Fritz's definition in 1961. During this time, disasters were considered an interruption of human behavior, which means a claim of life loss and injury. Within the classical periods, three formal definitions of a disaster were published. Killian (1954) indicated disasters demolish the social order, resulting in physical destruction and death. Wallas (1956) stated disasters generally are situations that include the threat of a disruption of an ordinarily effective process with remarkably increasing tension. Moore (1958) also indicated that disasters make people accept different behavior styles with life loss.

Fritz (1961) defined disaster as events concentrated in time and space, in which an entirely self-sufficient unit of society experiences severe danger inflicts losses on its members resulting in the disruption of social structure, and causes the shutdown of the fulfillment of all or some of society's essential functions. Fritz (1961) suggested the main components of the definition: First, disasters are social events. If an event does not impact people, it is not a disaster. Second, a disaster should cause social disruption for a specific group of people. Third, disasters cause the impacted group to go outside of the community for assistance. Fourth, a disaster is not an actual physical event, but rather the perception that an event will occur. For decades a lot of scholars have adopted the definition mentioned above and provided slight modification from the original meaning. Sjoberg (1962) called disasters an extreme, quite abrupt, and often unanticipated disruption of a social system that were beyond societal control. Cisin and Clark (1962) modified part of Fritz's definition by adding that a disaster is any occurrence that disturbs usual actions.

2.2. Disaster response and warning

The National Governor's Association (1979) presented the four phases of emergency management as follows: mitigation, preparedness, response, and recovery. Mitigation is an activity to reduce or eliminate the probability of a disaster, including land-use planning, insurance, and structural controls. Preparedness is an activity undertaken before the onset of a disaster to enhance the response. Preparedness includes training and education, buying items and planning. Response is an activity designed to provide emergency assistance, which includes search and rescue, medical care and feeding. Recovery is an activity to bring the affected area back to its normal or pre-disaster state, and this includes debris management, housing, and psychological assistance. The four phases of emergency management overlaps and influences each other (Phillips, Neal, and

Webb, 2016). Preparedness is closely related to the response phase because preparedness general refers to activities undertaken before a disaster to increase the response abilities (National Governors' Association, 1979, p. 13). Also, there will be an overlap between response and recovery because some communities will be engaged in emergency response missions while others will have moved on to disaster recovery tasks (Schwab, Topping, Eadie, Deyle and Smith, 1998).

When researchers explore the response phase among emergency management, they need some consideration. First, a scholar indicated two types of demands needed to respond to disasters successfully (Quarantelli, 1997). They are agent- and response-generated demands. The agent generated demands arise from the specific mechanisms by which a hazard agent causes casualties and damage, while response generated demands arise from organizing and implementing the emergency response. The former concept derives from the particular disaster agent such as a tornado, storm, earthquake, and wildfire. However, the latter idea is to utilize a system to manage personnel and resources effectively. For example, the National Response Framework shows 15 Emergency Support Functions (ESFs), which can be seen as response generated demands (Department of Homeland Security, 2013). Second, a disaster so severely disrupts routine or regular modes of human behavior that people may develop new norms and behavior patterns to guide their actions at that time. Thus, researchers need to understand two sets of norms, such as emergent norms and bureaucratic norms. Emergent norms describe human behavior during disasters, while bureaucratic norms mean the governmental response system. The author indicated that the problem is from conflicts between newly emergent norms and existing bureaucratic norms, and these conflicts can affect the disaster response process.

The typical disaster response to manage personnel and resources for emergency services is to use a Command-and-Control (C&C) approach. For example, the Incident Command System (ICS) reflects the above concept. Chang (2017) indicated the benefits of using the C&C approach as follows: 1) ICS produces a comprehensive arrangement on planning and responding to a disaster, 2) ICS offers unified terminology, 3) ICS provides a controllable span of control. Thus, after the WTC attacks in the U.S., organizations involved in emergency management at the local, state, and federal levels were mandated to utilize the ICS to structure on-field response efforts (Jensen and Waugh, 2014). However, some scholars suggested that there were some limitations to the ICS. Neal and Webb (2006) indicated that many organizational factors impeded a widespread use of ICS during the response to Hurricane Katrina. These factors included a lack of training, little understanding of how to use ICS, and a belief that other systems could work better. Thus, groups of scholars provided some suggestions of how to deal with these kinds of limitations.

Dynes (1994) suggested using the problem-solving model that focuses on Continuity, Coordination, and Cooperation (3Cs) to replace the C&C model. First, continuity means that the best forecaster of behavior in a disaster is the behavior before the accident. Second, coordination focuses on increasing inter-organizational assistance in pre-disaster situations. Third, cooperation focuses on ways to effectively rearrange human and material resources in the community. Also, Neal and Philip (1995) emphasized the Emergent Human Resource Model (EHRM) approach to emergency management over the C&C approach because its strict, bureaucratic approaches to disaster management generally result in ineffective disaster responses.

Dynes and Aguirre (1976) indicated that the four types of groups and organizational behaviors in disasters from a cross-classification of the trait of the disaster tasks assumed by groups and their emergency historical structures. Importantly, all discussions above are related to managing three types of groups, such as type I, II, and III. Table 1 describes four kinds of groups, which can be found at the scenes of disasters.

Table 1. Types of group behavior in disaster (Dynes and Aguirre, 1976)

		Tasks	
		Regular	Non-regular
Structure	Old	Type I (Established)	Type III (Extending)
	New	Type II (Expanding)	Type IV (Emergent)

Notably, during disaster response, it is imperative to consider how traditional disaster responders (the type 1 organization) work with the extending, expending, and emergent groups (type 2, 3, and 4) on the sites. However, emergency managers should manage type IV groups, which mean citizens and volunteer groups. Harrald (2006) explained that the response system should be an open system that can collect and transmit information from public and non-governmental organizations. Open systems can facilitate shared decision-making and improvisation in the face of unexpected events or situations. Also, Murphy and Pudlo (2017) introduced the concept of making decisions together. They focused on understanding how nonprofit and church leaders perceive their organizations' collaboration with others. They indicated that NPOs and churches should have a primary or secondary mission to collaborate with organizations involved in emergency management structures.

This study focuses on the response phase by concentrating on examining how international and U.S. domestic students respond to tornado warnings and watches. To date, many studies have focused on warning and protective actions. This includes studies focused on warning message itself (Baker 1995; Lindell and Hwang 2008; Sorensen 2000; Wu, Lindell, and Prater 2015); risk information sources (Frewer, Scholderer, and Bredahl 2003; Kahlor 2007; Wu et al. 2017); protective action decision making (Jon et al. 2016; Kang, Lindell, and Prater 2007; Lindell and Hwang 2008; Weinstein 1989); evacuation logistic (Wu et al. 2013; Wu, Lindell, and Prater 2012); and evacuation reentry (Lin et al. 2014; Siebeneck et al. 2013). Many of these studies are based on different warning and protective action models. The following sections will review the models that explain how people receive warning messages and decide on protective actions.

2.3. Risk and protective action related model or theories

2.3.1. Hazard taxonomy

Slovic (1987) suggested a ‘‘hazard taxonomy’’ psychometric model. The model is used to understand and predict an individual’s response to risk. His study introduces a risk factor map as shown in Figure 1, which shows risk perception as a function of the grade to which a risk is not known or feared (Hoekstra et al., 2010). The author suggested four types of risk: First, the upper left area describes those hazards that are unknown and not feared (for example, caffeine). Second, the upper right area shows those that are unknown and more feared, including tornadoes. Third, the lower-left area describes those that are known and not feared, such as elevators. Fourth, the lower right area shows those whose risks are more recognized and more feared, including nuclear weapons.

Figure 1. Simplified version of Slovic's (1987) risk factor map / Source: Hoekstra et al., (2010)

2.3.2. Warning response model

Mileti and Sorenson (1990) described the rudimentary social-psychological process that highlights the difference in the public response to a warning. The authors indicated that people experience some serial steps in which they reflect on several features of the decision facing them before taking action. Accordingly, this results in numerous psychological and behavioral consequences, and the process is outlined by the sender and receiver component. Figure 2 shows the warning response process as follows: 1) hearing the warning 2) understanding the warning 3) believing the warning is trustworthy 4) personalizing the warning 5) deciding and responding and, finally, 6) confirming.

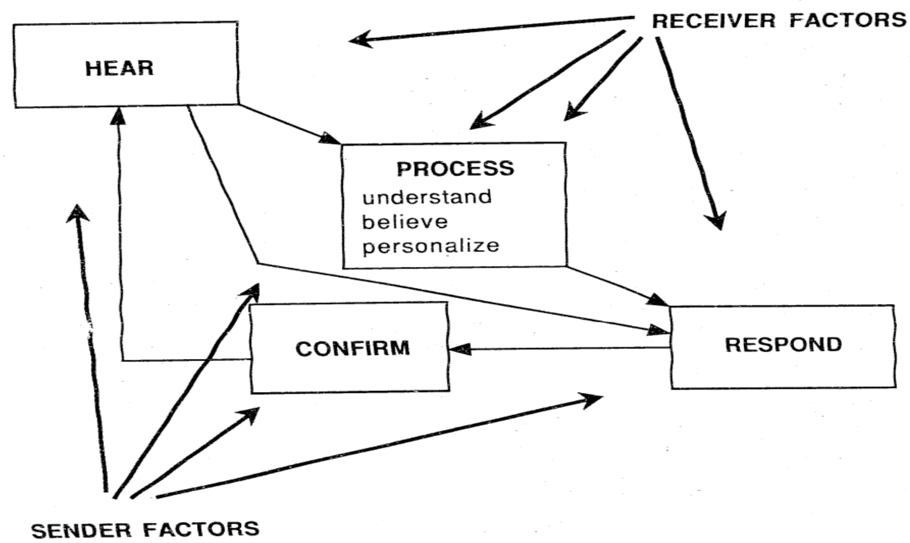


Figure 2: A model for determinants and consequences of public warning response / Source: Mileti and Sorenson (1999)

Donner, Rodriguez, Diaz (2007) examined public response to tornado alerts through the use of the theoretical framework supplied by Mileti et al. (2000). The authors mentioned a high level of complexity in terms of a process movement, reciprocal action, and exchange of information and social characteristics. They indicated that the meteorological method to public safety could be significantly improved with the help of social science methods and data.

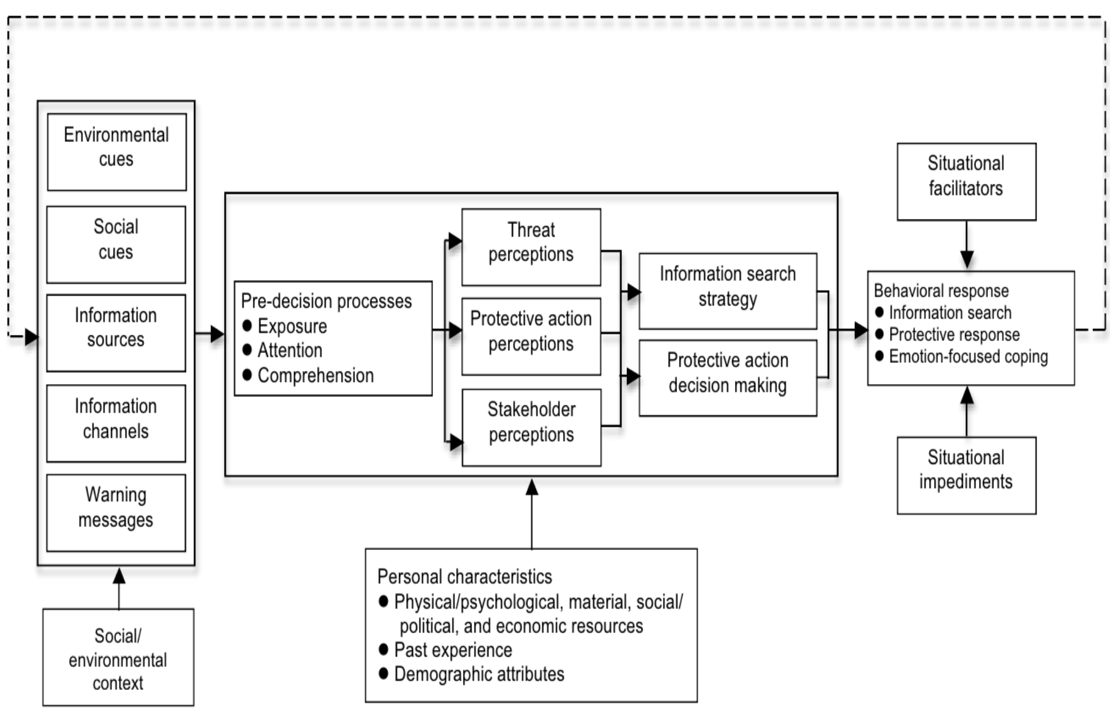
2.3.3. Person-relative-to-event(PrE) theory

The Person-relative-to-Event (PrE) theory of handling threats highlights the relationship between assessed threat levels compared to personal resources and personal responsibility (Mulilis & Duval (1997). The theory forecasts that when resources are assessed as sufficient compared to the magnitude of the threat, the problem-focused coping will increase as the threat increases. On the other hand, when resources are assessed as insufficient concerning the threat scale, problem-focused coping will decrease as the threat increases (Mulilis & Duval,1999). Mulilis & Duval (1997) utilized this theory to examine the influence of negative threat appeals on preparedness behavior about tornadoes. According to the authors, The PrE theory forecasts that when individuals have low responsibility, they cannot have more problem-focused coping. Chaney, Weaver, Youngblood, & Pitts (2013) offered that a concept associated with PrE theory is the location of control (LOC), which means general beliefs about who or what controls the results of an individual's life. Those who believe that the results of their life depend on their endeavors or intelligence have internal LOCs. On the other hand, external LOCs suggest that those who believe that outcomes rely heavily on external environmental conditions, including fate (Spittal et al. 2002). Sims and Bauman (1972) explained that individuals with internal LOCs have a more efficient response to tornado warnings.

2.3.4. Proactive Action Decision Model (PADM)

Lindell (2018) modified the Proactive Action Decision Model (PADM) to describe the process of taking protective action. Figure 3 shows that the protective action decision-making process of PADM begins with environmental cues, social cues, and warnings. Environmental cues are sights, smells, or sounds, whereas social cues stem from observations of others' behavior. Warnings are messages that are transferred from a source via a channel to a receiver, resulting in effects that depend on the receivers' characteristics. The relevant effects are changes in receivers' beliefs and behaviors, which include their physical, psychomotor, and cognitive abilities as well as their economic and social resources. Environmental cues, social cues, and socially spread warnings begin a chain of pre-decisional procedures to derive critical awareness of the ecological threat, substitute protective actions, and related shareholders. This awareness provides the basis for the determination of protective measures, the result of which is combined with a situational facilitator and disability, resulting in behavioral response. The dominant tendency is that such information urges the determination of protective actions, but in the process of determining protective measures, finding information occurs when there is uncertainty at a given stage. After the uncertainty is fixed, processing proceeds to the next step. Notably, the PADM forecasts that several kinds of graphical displays included in warning messages from social sources will have an effect on an individual's perception of the tornado information, as shown by their decisions that an environmental hazard will create damage. Sequentially, these judgments will influence their expectations of taking several forms of behavioral reactions, including information searching and protective action (Jon, Huang, & Lindell, 2018).

Figure 3. Information flow in PADM / Source: Lindell (2018)



2.3.5. Tornado risk and protective action

The four theories/models mentioned above help to understand risk perception and protective action. First, Slovic (1987) presented four classifications of risk factors and put the tornado in an unknown and dreaded risk area. In contrast, nuclear weapons are situated in a known and dreaded risk area. Second, Mileti and Sorenson (1990) indicated that people experience sequential steps in which they reflect on many components of the decision facing them before taking action. Third, Mulilis & Duval (1997) utilized the Person-relative-to-Event (PrE) model to examine the impact of fear or harmful threats to action for hazards such as tornadoes. Appeals against dangerous threats enhance the level of protection to mitigate the negative results of risks. The results show a significant form of behavioral changes that fit the forecasts produced by the model. Last, Lindell (2018) presented the PADM model to explain the processes of taking protective actions. The model shows the basic framework of the information flow. Notably, the author suggests a method of how a warning message leads to protective action.

These theories gave some inspiration to this study. First, in issuing warnings about tornado threats, the methods provide us with inspiration on what factors are essential for the most effective warning policy. Second, when conducting a study of people's protection action decision making, the theories provide us with the factors that need to be studied. Third, when people receive warnings about tornadoes, the methods show a systematic process of how they understand such warnings and take protective actions. The following sections focus on the variables and factors that will be examined in this study.

2.4. University student as a vulnerable population

Pine (2015) explained that the goal of vulnerability analysis is to detect the terrestrial areas that may be impacted, peoples who may be exposed to injury or demise, and what amenities, assets, or situation may be exposed to risk from the incident. Expressly, Cutter (2011) referred to the social vulnerability that explains the demographic characteristics of a social group that is somewhat susceptible to the adverse effects of risk. Based on Cutter (2011) and Pine's (2015) classification, students can be considered as a vulnerable population because college students are generally renters with lower income. Additionally, international students who are unfamiliar with the area can be susceptible to hazards.

Some scholars utilized undergraduate students for their research. Jauernic and Van Den Broeke (2017) conducted an online survey of over 600 undergraduate students registered at the University in Nebraska. And the authors found a significant relationship among demographics variables, risk perceptions, and response action. According to results, international students were more likely to search for shelter during the warning but had difficulty understanding warning polygons or correctly selecting the best protective actions. Meanwhile, most domestic students recognized safe zones in which to find shelter, but fewer knew the exact meaning of a tornado warning polygon. Domestic students considered parents/guardians and the university as the most well-liked tornado knowledge sources, whereas international students regarded friends and self-education as the most favorite sources.

Also, Lovekamp and Tate (2008) investigated college students' risk perception of tornadoes and disaster response actions at a Midwestern university. Utilizing questionnaires, the authors gathered a sample of 192 college students from various majors and ranks. They indicated that these students do know the potential severity of tornadoes, understand how to respond, but do not take many of the proper actions to defend themselves. Lovekamp and Tate (2008) especially emphasized that the vulnerability viewpoint should be reinvestigated and explained to include specific college students.

Meanwhile, Lovekamp and Mcmahon (2011) used focus group interviews with students to get data about their experience, risk perceptions, and response to a tornado at Union University in Jackson, Tenn., on February 6th in 2008. In particular, the authors presented the students three minutes of CNN visual material of the Union University tornado, examined their response to the disaster, and noted any alterations in their responses. Lovekamp et al. (2011) found that students generally have inadequate experience with disasters. Also, their level of disaster preparedness is low and many do not know their university's emergency plans. On top of that, they have a fatalistic mindset about the significance of preparing and believe the university will take good care of them. In addition, they mentioned that female students were much more likely to report being afraid of tornadoes. Despite these studies, research on international college students as a vulnerable class requires more experimental research based on comparative studies with U.S. domestic students.

2.5. Warning

Mileti & Sorensen (1990) reviewed over 200 articles on warning strategies and warning responses not only to examine the social science perspective but also to evaluate disaster public warning communications. They suggest: 1) changes in the nature and content of the warning had a significant impact on whether the public paid attention to the warning or not 2) characteristics of the warning recipient affected the warning response. 3) many researchers presented myths about the public response to disaster warning conflict with the knowledge gained from field surveys. Importantly, the authors showed that one warning method was not suitable for entire warning situations.

Other scholars researched the warning system of the United States. Sorensen (2000) mentioned that the United States did not have a complete national warning system that covered all the risks in all regions. Instead, public warning systems were scattered among other governments and the private sector. The author revealed that people were, therefore, unequally vulnerable to natural disasters because unequal readiness to issue warnings existed throughout the community. However, as of 2020, the advanced wireless technologies allowed researchers to develop a unified warning system called Wireless Emergency Alerts (WEA).

Some studies focused on tornado warning lead time. Hoekstra et al. (2011) found that tornado warnings are presently issued an average of 13 minutes before a tornado event occurs and are executed using a warn-on-detection concept. Nevertheless, technical improvements may introduce Warn-on-Forecast as a new warning concept. This change would allow tornado warnings to be issued one to two hours before the storm. The authors indicated that most respondents reported the situation would feel less life-threatening if given one-hour lead time. According to results, the community reactions to longer lead times may be complicated and situationally dependent.

Durage, Wirasinghe, and Ruwanpura (2013) showed that communities are impacted only when a tornado touches down on the ground. Early recognition of tornadoes and proper communication of warnings in the pre-touchdown phase helps the public to be ready and respond appropriately and effectively. Given that tornadoes are hard to predict and the warnings give only a very brief window of opportunity to prepare for evacuation to a secure underground or other location, each activity in the detection and warning phases is critically essential. Collins and Kapucu (2008) focused on informing public policymakers and the disaster management community about the use of early warning systems. Their research question is how local governments should provide early warning to citizens of impending danger. Collins et al. (2008) have clearly shown the life-saving effects of taking protective action when given an early warning for tornado events. The authors suggested that overuse and abuse of the radio warning system would undermine its effectiveness because the citizenry would turn off the pesky annoyance. Thus, the author presented that the warning would have to be issued only in times of dire consequence to be useful and pragmatic. Sutter and Erickson (2010) mentioned that the meaning of over-warning is to warn people who are not at risk. An incomplete understanding of the risks, constraints on technology, and the time required for a response make excessive warnings inevitable.

Sutter & Erickson (2010) investigated the cost of time spent on the tornado warning issued annually by the National Weather Service (NWS). The traditional county-based tornado warnings have cost the country considerably. Between 1996 and 2004, $2.7 billion was spent on 234 million hours of incidents. The county is relatively large compared to the area affected by the tornado. In October 2007, the NWS introduced a storm-based warning (SBW) for tornadoes that is expected to reduce the warning area by

70 - 75%. As a result, SBW will reduce the warning time of 160 million person-hours per year and create a value of $ 1.9 billion, as shown in figure 4.

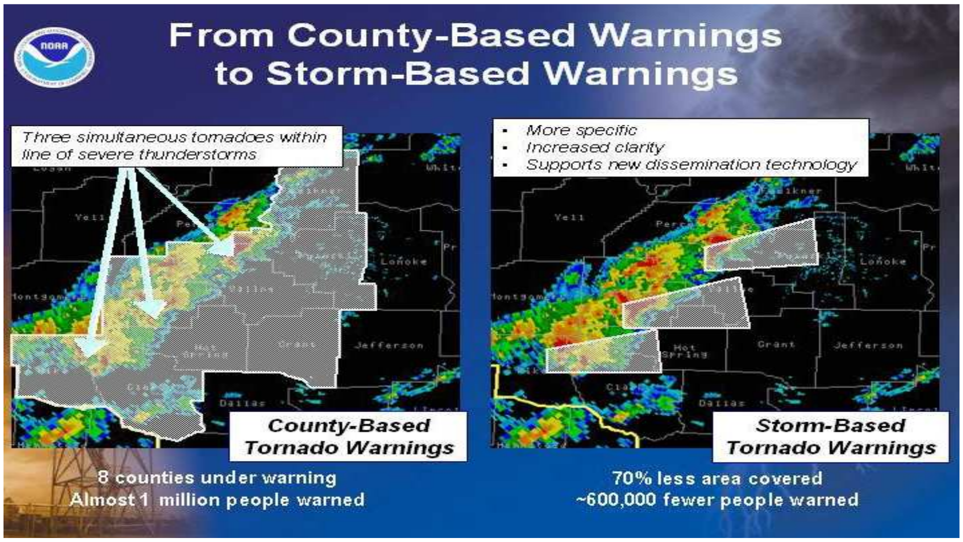


Figure 4. County-based warning vs. storm-based warning / Source: NOAA homepage (2015)

Hammer and Schmidlin (2002) surveyed 190 Oklahoma City residents of 65 homes that experienced EF4 or EF5 damage on May 3, 1999. Television was the most commonly cited source of the warning (89%), followed by telephone calls (37%), sirens (37%), AM/FM radio (25%), with 55% receiving the warning from more than one source. Nearly one-half (47%) of the residents left their houses before the tornado struck. Of those who left, 65% moved to a tornado shelter, of whom 70% moved to the shelter (median distance 30 m), and 30% drove their car to get to a shelter (median distance 4.8 km). Comstock et al. (2005) showed that residents who took less action said that the reason for doing so was inadequate warning and shelter. Also, firsthand experience of tornadoes prompts people to heed warnings when the adequate notification is received and to take effective protective action when the proper shelter is available. Thus, Comstock et al.

(2005) suggested that new technologies should be investigated. Specifically, the authors mentioned that the most common warning systems (television and tornado sirens) and other currently available warning systems (weather-band radios) should be improved.

Durage et al. (2014) indicated that repeated false warnings could hinder perceptions of trustworthiness, and people may not heed the warnings. Simmons and Sutter (2009) examined the dissimilarity in the false-alarm rates across the United States to check the effect of false-alarm in a regression methodology of tornado victims from 1986 through 2004. A statistically significant and sizeable false-alarm impact was identified: tornadoes that happen in an area with higher false-alarm rates kill and hurt more people. An escalation in the standard deviation of the false alarm rate increases the expected fatality between 12% and 29% and increases the expected injury between 14% and 32%. During this period, the reduction in the country's tornado false alarm rate reduced deaths by 4–11% and injuries by 4–13%.

Hodler (1982) pointed out that the public should be educated about the procedures used for impending tornado warnings. Seventeen percent of the interviewees did not know the meaning of the tornado warning. The proper reaction to tornado warnings must be continuously taught. Forty percent of the interviewees pointed out that they did not take any action or tried to see the tornado because of curiosity. Thus, to make people more aware of tornado alerts, additional factors need to be considered using a more interdisciplinary research approach by incorporating psychology, sociology, information science and disaster science.

2.6. Tornado polygon study

Nagele and Trainor (2012) collected data that centered on protective action decision making in counties that were affected by a tornado warning. While a meaningful relationship between being inside the warning polygon and taking protective action was not revealed, the authors conclude that polygon size was a significant factor. They suggested that future work on storm-based warnings focus on not only the warnings' dissemination and reception but also the optimization of the polygons themselves. Notably, the authors indicated that in events where the polygons were smaller than 50% of the county, individuals were more likely to take protective action. So, they underlined that the polygons should be optimized to generate the desired results.

Other scholars utilized several types of polygons for their study. Lindell, Huang, Wei & Samuelson (2016) pointed out that there is no standardized definition of the probability of a tornado polygon, so it is unclear how the warning recipients are aware of the probability of a tornado. The authors surveyed 155 participants who reacted to 15 simulated warning polygons. After viewing each polygon, they assessed not only the likelihood that a tornado would hit their location but also the possibility of taking nine different protective measures. The results showed that the participants' responses were highest at the center of the polygon. Their responses were lower at the edge of the polygon, but lowest at the edge beyond the polygon. Also, Jon, Huang, & Lindell (2018) utilized 145 participants who showed 22 hypothetical scenarios in one of the four displays, which consist of deterministic polygon, a deterministic polygon plus radar image, gradient polygon, and gradient polygon plus radar image. The participants provided the probability of estimating the numerical strike chance (PS) of each polygon and taking seven different protective actions. According to the results, the deterministic polygon display results in the highest PS in the center of the polygon. A deterministic polygon with the radar display, gradient polygon display, gradient polygon with radar display produced high PS from the center of the polygon and at the edge closest to the tornado storm cell. The authors confirmed the result that when the participants showed higher PS judgment when they watched polygon plus a natural radar image rather than when they watched the polygon without any graphic image.

As far as probabilistic information, Miran, Ling, Gerard, & Rothfusz (2018) examined how people's protection measures change by presenting information on uncertainty about the happening of tornadoes through Probabilistic Hazard Information (PHI). In the experiment, 50 participants saw a visual indication of probability information and deterministic warnings, answering the expected protection in scenarios. Right after obtaining weather information, the ratio of people who moved to shelter increased enormously when a tornado threat was nearby. The authors showed that the probability of taking protective action was significantly less when uncertain information was given to people less than 20 minutes behind the lead time. If the lead time was less than 10 minutes, the probability of seeking shelter was enhanced from 71% to 94%, and if the lead time was between 10 minutes and 20 minutes, the chance was enhanced from 53% to 70%.

Similarly, Ash, Schumann, and Bowser (2013) utilized probabilistic tornado warning to examine the reaction to color schemes and different locations. Surveys of college students are used to evaluate the level of perceived fear of a series of hypothetical warning scenarios and the likelihood of protection action. The key research questions are related to the following topics: 1) the change of reactions across warning designs; 2) gathering of extreme reactions in each type; 3) The change in response near the edge of the polygon. The results showed various responses to tornado warnings depending on visual design choices. These results emphasized the need for more comprehensive research on the visualization of weather disaster warning distribution.

Klockow (2013) performed an experimental study by utilizing deterministic as well as color-coded probabilistic polygons. Different colors of the probabilistic polygons meant different levels of tornado probability. The author used red-gradient and diverging schemes polygons. According to the result, he did not identify any significant difference in people's perception of the possibility of tornado occurrence among the different types of polygons. Jon, Huang, and Lindell (2018a) examined the impact of adding radar images of storm cells on the deterministic polygon type. Even if the centroid effect was not removed by including the radar images, the radar images impacted people's judgment of the tornado in the locations inside the polygon. The above studies show that authorities use polygons to notify residents of the risk of tornados. However, research on how to deepen their understanding of polygons efficiently is necessary for those who are unfamiliar with this method or have never seen it.

2.7. Tornado experience study

May and Bigham (2012) explained that experience is a crucial tool by which people are conscious of, evaluate, and react to risk. The authors asserted that we could better know how to reduce social damage from future threats by better comprehending people's previous lessons. Several scholars researched the relationship between disaster experience and disaster. Becker, Paton, Johnston, Ronan, & McClure, (2017) revealed that people's experiences affect their conviction about whether they should prepare for disaster and how. The authors suggested four types of experiences: direct, indirect, vicarious, and life experience. The authors explained that experience has seven different types of influence on disaster preparedness. Also, Silver & Andrey (2014) examined the roles of previous disaster experience and socio-demographics on the decision-making process during two successive tornado events such as F3 tornado on August 21, 2011, and tornado warning days later on August 24, 2011. The authors showed a rise in the numbers of people who took protective action on August 24, 2011, irrespective of the respondents' presence or absence during the August 21 tornado. The scholars showed that the only statistically significant sociodemographic variable for the tornado on August 21, 2011, was gender (female). Finally, the authors revealed that the prior direct or indirect disaster experience and socio-demographics interconnected in various multifaceted ways. Also, Wallace, Keys-Mathews, and Hill (2015) explored the ways direct tornado experience affects people's risk perception by using statistical analyses.

Interestingly, the authors showed that direct experience was less motivation to change than expected. Additionally, augmented or reduced perception may be related to a more shared social experience. Namely, the scholars found that experience extends beyond direct experience. Furthermore, Demuth (2018) developed the six dimensions of measures of previous tornado experiences by using two surveys of the residents in tornado-prone regions: people's awareness of the tornado risk, personalization of the risk, the intrusive impacts, and impacts vicariously experienced, communication received, and negative emotional responses. The authors revealed that the dimensions were correlated with tornado risk perceptions measured as cognitive-affective and as the perceived probability of results. Also, Paul, Stimers, and Caldas (2015) explored the factors which were related to response to tornado warning by surveying survivors in Joplin tornado on May 22, 2011. The authors identified prior tornado experience as statistically significant determinants of compliance with tornado warnings. Additionally, Schumann, Ash, and Bowser (2018) found that previous tornado experience, as well as information-seeking habits and local disaster culture, played significant roles in warning response. As shown, it is necessary to study how these prior experiences are linked to the tornado alert through the classification of more systematic experiences rather than simple experiences of tornadoes.

2.8. Research objectives

Previous studies (Lindell et al., 2018; Ash et al., 2014; Miran et al., 2018) showed how deterministic and probabilistic polygons affect the protection actions, but they did not allow the participants to make their own decision to search for risk information. Therefore, this study will utilize *DynaSearch* to investigate this topic. In this study, *DynaSearch* will allow participants to choose their preferred risk information among five types of information (gradient polygon only, gradient polygon plus location, gradient polygon plus trackline, gradient polygon plus probability, and gradient polygon plus radar image). As of today, no scholars have investigated the relationship between risk information and protection behavior using international and domestic student participants who live in Oklahoma, where many tornadoes in the United States hit.

The goal of this study is to investigate how international and U.S. domestic college students respond to tornado warnings through experimental studies. Thus, the purpose of this study is threefold. First, we want to find the most preferred probabilistic tornado information for both international and U.S. domestic students. Second, we want to investigate participants' information search behavior for each tornado alert type (watch and warning) as well as for advisory types (advisory 1 - advisory 5). Third, we want to investigate how participants' risk perception, prior experience, and demographic factors affect students' response to tornado warnings. The following section suggests 21 research questions and five hypotheses to show the specific direction of this study.

2.9. Research hypotheses and questions

The above studies and models have led to the development of research questions (RQs) and hypotheses (RHs) addressing the relationship between tornado risk information and protective action preference. The research hypotheses and questions consist of four parts, such as tornado information search, risk perception, protective action, and tornado experience and life experience.

2.9.1. Information search research question

ISRQ1. What is the most preferred tornado information among the five information displays (gradient polygon only, gradient polygon plus location, gradient polygon plus track-line, gradient polygon plus tornado strike probability, and gradient polygon plus radar image)?

ISRQ2: Will participants have different tornado information preferences for different tornado alert types (watch, warning)?

ISRQ3: Will participants have different tornado information preferences for different advisory types (advisory 1, advisory 2, advisory 3, advisory 4, advisory 5)?

ISRQ4: Do international and domestic student participants have different tornado information preferences after controlling for demographic characteristics?

ISRQ5: What are the correlations among information search and demographic variables?

2.9.2. Experience on the experiment research questions

EERQ1: What is the most preferred tornado risk information?

2.9.3. Risk perception research questions and research hypotheses

RPRQ1. Do international and domestic student participants have different tornado risk perceptions after controlling for demographic characteristics?

RPRH1. Participants who are assigned to the tornado watch group and participants who are assigned to the tornado warning group have different risk perceptions after viewing the first advisory.

RPRH2. Participants who are assigned to the tornado watch group and participants who are assigned to the tornado warning group have different risk perceptions after viewing the second advisory.

RPRH3. Participants who are assigned to the tornado watch group and participants who are assigned to the tornado warning group have different risk perceptions after viewing the third advisory.

RPRH4. Participants who are assigned to the tornado watch group and participants who are assigned to the tornado warning group have different risk perceptions after viewing the fourth advisory.

RPRH5. Participants who are assigned to the tornado watch group and participants who are assigned to the tornado warning group have different risk perceptions after viewing the fifth advisory.

RPRQ2: What are the correlations among risk perception and demographic variables?

2.9.4. protective action research questions and hypotheses

PARQ1: Do international and domestic student participants have different protective action selections under advisory 1?

PARQ2: Do international and domestic student participants have different protective action selections under advisory 2?

PARQ3: Do international and domestic student participants have different protective action selections under advisory 3?

PARQ4: Do international and domestic student participants have different protective action selections under advisory 4?

PARQ5: Do international and domestic student participants have different protective action selections under advisory 5?

PARH1 Participants who are assigned to the tornado watch group and participants who are assigned to the tornado warning group have different protective action selections after viewing the first advisory.

PARH2: Participants who are assigned to the tornado watch group and participants who are assigned to the tornado warning group have different protective action selections after viewing the second advisory.

PARH3: Participants who are assigned to the tornado watch group and participants who are assigned to the tornado warning group have different protective action selections after viewing the third advisory.

PARH4: Participants who are assigned to the tornado watch group and participants who are assigned to the tornado warning group have different protective action selections after viewing the fourth advisory.

PARH5: Participants who are assigned to the tornado watch group and participants who are assigned to the tornado warning group have different protective action selections after viewing the fifth advisory.

PARQ6: What are the correlations among protective action and demographic variables?

2.9.5. Tornado experience and life experience research questions

TELEQ1: What are the correlations among tornado experience, risk perception and protective action under advisory 1?

TELEQ2: What are the correlations among tornado experience, risk perception and protective action under advisory 2?

TELEQ3: What are the correlations among tornado experience, risk perception and protective action under advisory 3?

TELEQ4: What are the correlations among tornado experience, risk perception and protective action under advisory 4?

TELEQ5: What are the correlations among tornado experience, risk perception and protective action under advisory 5?

TELEQ6: What are the correlations among tornado experience, click count and click duration under advisory1?

TELEQ7: What are the correlations among tornado experience, click count and click duration under advisory2?

TELEQ8: What are the correlations among tornado experience, click count and click duration under advisory3?

TELEQ9: What are the correlations among tornado experience, click count and click duration under advisory4?

TELEQ10: What are the correlations among tornado experience, click count and click duration under advisory5?

CHAPTER III

METHODOLOGY

3.1. Research design

3.1.1. Experimental design

This experiment has two between-subject factors (*student type:* international and domestic students/*tornado alert type:* watch and warning) and two within-subject factors (*tornado risk information display type:* gradient polygon only, gradient polygon with location, gradient polygon with track-line, gradient polygon with probability, gradient polygon with radar image/*tornado advisories* [advisory 1, advisory 2, advisory 3, advisory 4, advisory 5] shown as Appendix D - E). For between-subject factors, participants consist of international and U.S. domestic students. It is essential to take into consideration the difference between international and U.S. domestic students. Thus, two standards were used for the definition of two types of students. Those standards are U.S. citizenship and high school place. First, for U.S. domestic students, the experimenter used participants who are both U.S. citizens and U.S. high school graduates. Second, for international students, the experimenter used participants who are both non-U.S. citizens and non-U.S. high school graduates. After collecting data, the experimenter excluded some students from U.S. domestic student category because they are U.S citizens but did not graduate from a U.S. high school. The experimenter used two questions to find the difference between the two groups: 1) In which country is your high school located? 2) Are you a U.S. citizen?

Also, participants received two types of weather alert information: watch and warning. *DynaSearch* program randomly assigned participants into two groups: watch and warning. Participants who are assigned to the tornado watch group saw yellow tornado risk information while participants who are assigned to the tornado warning group saw red tornado risk information. For within-subject factors, participants received five tornado risk information displays such as gradient polygon only, gradient polygon with location, gradient polygon with track-line, gradient polygon with probability, gradient polygon with radar image. The researcher used a black dot inside the polygon to indicate the location of the participants during the experiment and an arrow to indicate the direction of the tornado's movement. The researcher used numerical probabilities to represent the probability of the occurrence of a tornado. Radar images that are used by the Meteorological Agency for weather forecasting were utilized. Also, participants received five different weather advisories (advisory 1, advisory 2, advisory 3, advisory 4, and advisory 5). Each Advisory included time and date information to supply participants with specific experiment conditions as follows: Advisory 1: It is 2:00 PM, on March 3, 2020; Advisory 2: 10 minutes have passed. It is 2:10 PM, on March 3, 2020; advisory 3: another 10 minutes have passed. It is 2:20 PM, on March 3, 2020; advisory 4: another 10 minutes have passed. It is 2:30 PM, on March 3, 2020; advisory 5: another 10 minutes have passed. It is 2:40 PM, on March 3, 2020. Experimental resources are aggregated into *DynaSearch*, a software that permits participants to search graphic, numeric, and textual information about threats that change over time (Wu et al., 2016; Lindell et al., 2018). The purpose of this study is to compare *DynaSearch* data on individual choices to produce essential data on the decision-making process of protective action for both international and U.S. domestic college students.

3.1.2. Participants

The unit of analysis for this study is individual college students. *G*Power* is a free statistical power analysis tool that was provided by the Department of Psychology, Heinrich Heine Universität, Düsseldorf, Germany. The researcher used the tool to calculate the statistical power and sample size requirement. According to the Power analysis, at least 40 people should be obtained for each group to conduct meaningful analysis. This is the reason why we need at least 40 participants to make an effect size value over 0.5 and power value over 0.8. Finally, the researcher recruited 112 international students and 186 U.S. domestic students for each group. Thus, the sample size presented enough power to identify differences among the groups. 58 international students were randomly assigned to the watch alert group, and 54 international students were randomly assigned to the warning alert group. 101 U.S. domestic students were randomly assigned to the watch alert group, and 85 U.S. domestic students were randomly assigned to the warning alert group. Data was collected from 298 students, which consisted of both 112 international and 186 domestic students at Oklahoma State University in the Fall semester of 2019. A total of 349 participants attended this experiment. Three participants were removed because they were non-U.S. citizens but had graduated from a U.S. high school. Also, 48 participants were removed because they did not finish the experiment. Initially, 349 students participated in the research, but only

298 data were used for analysis because the specific conditions were not met. The specific numbers are shown in the following table 1.

Table 1. Total data collection results (349 participants)

Student type	International	U.S. domestic	Exclusion 1	Exclusion 2
Number	112 Watch: 58 Warning:54	186 Watch: 101 Warning: 85	3	48

Exclusion 1: 3 participants are Non-U.S. citizen but U.S. high school graduate students

Exclusion 2: 48 participants did not finish the experiment

3.1.3. Procedure

After getting permission from the Oklahoma State University Institutional Review Board (IRB), the researcher asked instructors to briefly explain the experimental study to students in their class and gather data from them. The researcher requested a total of 36 instructors at OSU, and 20 of them were able to have their students participate in the study. After explaining how to participate in the experiment with a brief PowerPoint file, the researcher collected analyzable data from 298 students. During the experiments, the experimenter told study participants to imagine watching TV in their home in an afternoon. While staying in his/her home, a TV newscaster will report that several thunderstorms are going to move northeast at 20 mph, and the NWS issues either a tornado watch shown by yellow polygons or a tornado warning shown by red polygons.

Each tornado scenario shown in appendix D and E was displayed to the participants. The different types of gradient tornado polygons were shown by a trapezoid that was the same size and orientation in all 25 pictures. First, the gradient polygon display showed five polygons with five layers of boundaries that indicate the watched (warned) area from the unwatched (unwarned) area over time. Second, the red gradient polygons with location showed the black dot and five polygons with five layers of boundaries that divided the watched (warned) area from the unwatched (unwarned) area over time. Third, the gradient polygons with track-line showed the black arrow track-line and five polygons with five layers of boundaries that divided the watched (warned) area from the unwatched (unwarned) area over time. Fourth, the gradient polygons with probability showed the black probability percent and five polygons with five layers of boundaries that divided the watched (warned) area from the unwatched (unwarned) area over time. Last, the gradient polygons with radar image showed the radar image and five polygons with five layers of boundaries that divided the watched (warned) area from the unwatched (unwarned) area over time.

Each participant viewed all five tornado advisories but saw only one type of display (i.e., warning/watch display is a between-subjects manipulation). After viewing each advisory, participants had to answer questions about their risk perceptions and the likelihood of taking each of di□erent protective actions, as shown in appendix A. There were no constraints on the amount of time the participants could take to complete their responses to risk perception and protective action selection questions; however, participants only had three minutes to search for different types of tornado information that was displayed on each tornado advisories.

Next, after going through all the tornado advisories, participants reported their experience with the experiment. They answered four types of questions about tornado experiences, such as direct, indirect, vicarious, and life experience. Also, responders were asked to report their age, sex, marital status, ethnicity, highest education level (less than high school, high school graduate, some college/vocational school, freshman, sophomore, junior, senior, graduate student, English language institute student), total family income, ownership of house, rental status of residence, high school location (state, country), residency type (on-campus, off-campus).

3.2. Measures

3.2.1. Independent variables

Based on the research questions and hypotheses, there are five types of independent variables in this study. The first one is the student type (international student, U.S. domestic student). The second independent variable is tornado risk information display types (gradient polygon only, gradient polygon with location, gradient polygon with trackline, gradient polygon with tornado strike probability, gradient polygon with radar image). The third independent variable is tornado alert type (watch, warning). The fourth independent variable is advisory type (advisory 1, advisory 2, advisory 3, advisory 4, advisory 5). The last independent variable is risk perception (Q1 = significant damage to your home or apartment, Q2 = significant damage to your property?, Q3 = injury to you or members of your family?, Q4 = disruption to your education or employment)? Sixth, it is protective action types (Q5 = Ignore/continue what I am doing, Q6 = Protect/secure private property Q7 = Monitor TV or radio, Q8 = Stay home and move to an interior room in the home, Q9 = Leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house, Q10 = Leave my home and take shelter at a public tornado shelter, Q11 = Leave my home with no destination in mind, simply to get out of the path of the tornado). Lastly, demographic variables such as experience, age, sex, ethnicity, education level, high school location, resident type were used for control variables.

3.2.2. Dependent variables

Based on the research questions and hypotheses, the dependent variables consist of four elements. First, it is a tornado information preference. We will measure the variable by counts and duration, which the participants click on the *DynaSearch* system. Second, it is preferred tornado information. This is measured by the self-reported tornado risk information display use in a *DynaSearch* questionnaire page. Third, it is the students' risk perception. We will measure it with four questions as follows: 1) "how likely do you think a tornado will cause significant damage to your home or apartment," 2) " how likely do you think a major tornado will cause significant damage to your property," 3) "how likely do you think a major tornado will cause injury to you or members of your family," 4) "how likely do you think a major tornado will disrupt your education or employment." Fourth, it is the students' protective action. We will measure it with seven questions as follows: When a tornado watch/warning is issued, what is your response? 1) "continue what I am doing," 2) "protect private property," 3) "monitor TV or radio," 4) "stay home and move to an interior room in the home," 5) "leave my home and take shelter in the ground tornado shelter at a nearby neighbor, friend, or families' home," 6) "leave my home and take shelter at a public tornado shelter," 7) "leave my home with no destination."

3.3. Analytical method

The researcher utilized Statistics Package for Social Science (SPSS) 25.0 to analyze the collected research data which were collected through the *DynaSearch*. For analyzing the results, the researcher applied statistical tests including frequency distribution, Cronbach's Alpha test, independent sample t-test, and repeated measure Analysis of Variance (ANOVA), two-factor mixed-design ANOVA, ANCOVA, and correlation

(Appendix C). The independent sample t-test was used to compare two groups. When comparing three or more groups, ANOVA was used. Based on *DynaSearch* results with SPSS analyses, the relationship between tornado risk information display and student type(international/U.S. domestic) was examined. Also, the relationship between tornado risk information display and alert type(watch/warning) was examined. Besides, the relationship between tornado risk perception and protective action was examined. Also, the relationship between tornado experience and protective action was examined. In addition, the relationship between socioeconomic variables such as age, sex, ethnicity, education level, high school location, residency type, and the dependent variables was investigated.

CHAPTER IV

RESULTS

4.1. Descriptive Statistics

This study collected respondents' age, gender, nationality, marital status, ethnicity, education, family income, high school location and their disaster related experiences. The followings show the descriptive statistics for these demographic variables.

Age. The average age of the respondents was 21.8, and their ages ranged from 18 to 54.

Gender. The number of male participants was 148 (49.7%), and the number of female participants was 150 (50.3%).

Nationality. The number of international student participants was 112 (37.6%), and the number of U.S. domestic student participants was 186 (62.4%).

Marriage. Married participants were 28 (9.4%), single participants were 268 (89.9%), and divorced participants were 2 (0.7%).

Ethnicity. Figure 1 shows ethnicity; African Americans were 12 (4.0%), Asian/Pacific islander was 57 (19.1%), Caucasian was 149 (50%), Hispanic were 16 (5.4%), and Native Americans were 16 (5.4%).

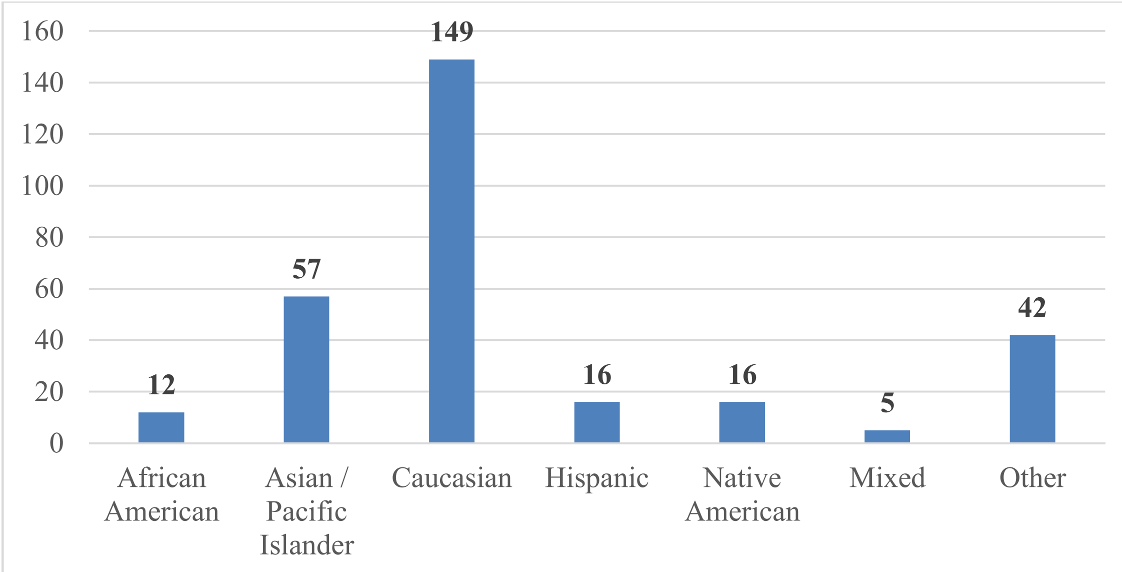


Figure 1. Ethnicity statistics

Education. Figure 2 shows the participants' education level. The number of college freshman was 69 (23.2%), college sophomore was 74 (24.8%), college junior was 37 (12.4%), college senior was 19 (6.4%), graduate students were 74 (24.8%), and OSU English Language Institute students were 3 (1%).

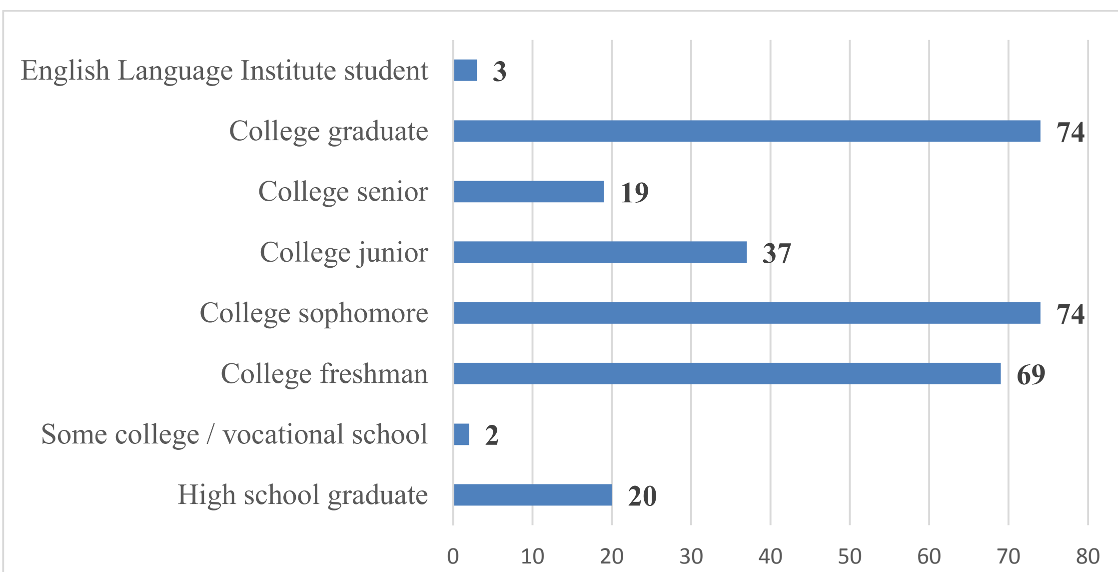


Figure 2. Education statistics

Family income. Of those who responded, 60 (20.1%) respondents reported family incomes were less than $30,000, while 44 (14.8%) respondents reported family incomes were $30,000 – $ 54,999. And 60 (20.1%) respondents reported family incomes were $55000 – $79,999, 46 (15.4%) respondents reported that family incomes were $80,000 – 104,999, 30 (10.1%) respondents reported that family incomes were $105,000 - $129,999, and 55 (18.5%) respondents reported that family incomes were more than $130,000; 216 (72.5%) of respondents were renter and 81 (27.2%) of respondents were not renter; 138 (46.3%) of respondents reported that they lived on campus or university housing, and 158 (53%) reported that they did not lived on campus or university housing. The figure 3 shows the participants' high school country.

High school country. Figure 3 shows that the participants were from 27 countries. One hundred eight-six participants graduated from high school in the U.S., 19 participants were from Kuwait, 17 participants were from China, 15 participants were from Saudi Arabia, 11 participants were from Japan, and seven participants were from South Korea; 4 students graduated from Germany and Bangladesh; 3 students graduated from high schools in India, Mexico, and Nigeria, respectively; 2 students graduated from high school in Sri Lanka, Iraq, and Canada; 1 student graduated from high school in Turkey, Thailand, Spain, Kazakhstan, Iran, Indonesia, Greece, France, Finland, Congo, Colombia, and Brazil.

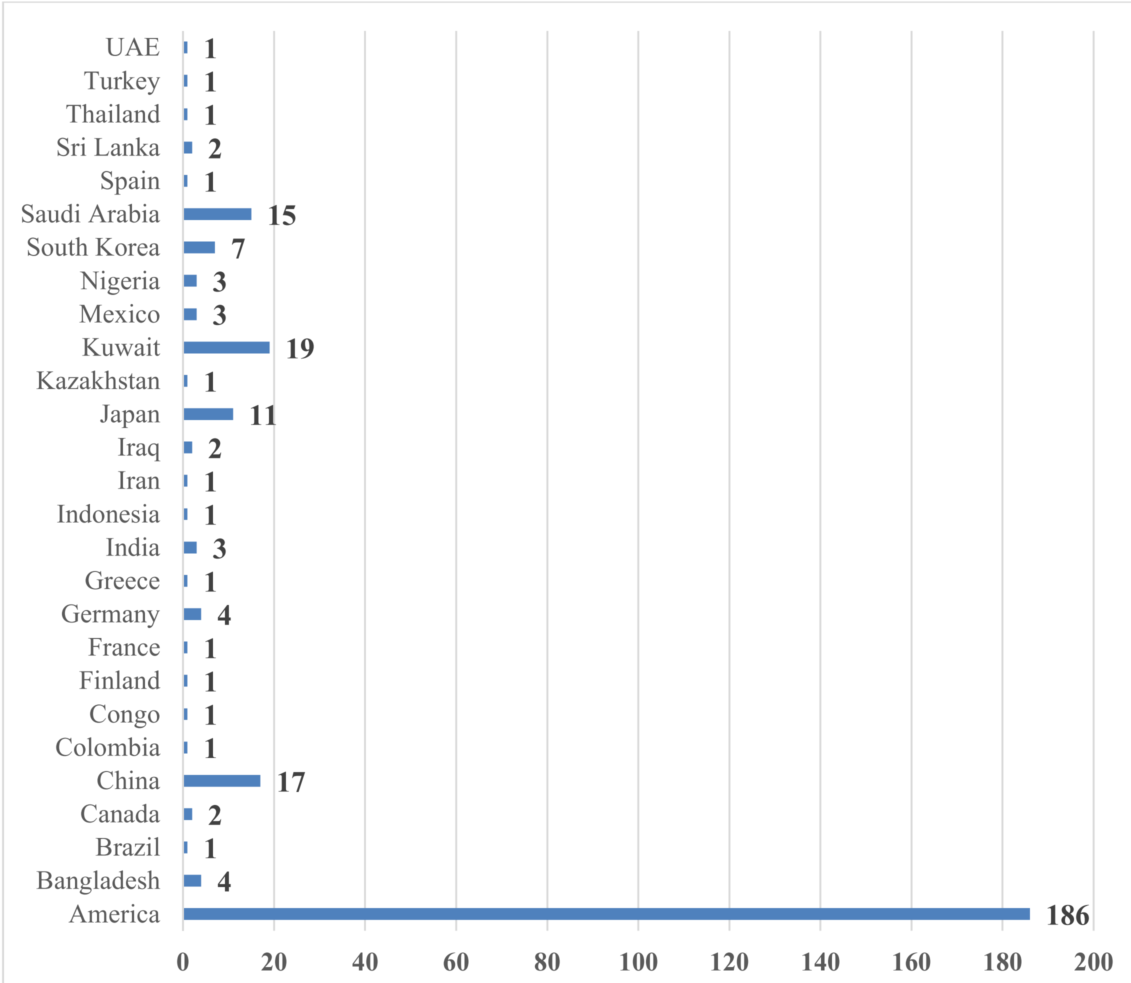


Figure 3. High school place statistics

Direct experience. One hundred thirty-nine participants (46%) have physically felt the tornado wind; however, 158 participants (53%) did not. Two hundred thirty-nine participants (80.2%) have received any tornado alert threat information such as watch/warning and took protective action; however, 59 participants (19.8%) did not. Sixty-one participants (20.5%) have experienced a tornado that caused damage to their home; however, 235(78.9%) did not. One hundred twenty participants (40.3%) have experienced a tornado that caused injury to themselves or members of their family; however, 178 participants (59.7%) did not.

Vicarious experience. One hundred seventy-nine participants (60.1%) reported that their friends, relatives, neighbors, or coworkers that they know personally experienced a tornado that caused damage to their home; however, 118 participants (39.6%) did not have any of the people mentioned above. Seventy-three participants (24.5%) reported that their friends, relatives, neighbors, or coworkers that they know personally experienced a tornado that caused the injury; however, 224 participants (75.2%) did not have any of the people mentioned above. One hundred seventy-three participants (58.1%) reported that their friends, relatives, neighbors or coworkers that they know personally experienced a tornado that caused a disruption that prevented them from going to school or workplace; however 124 participants (41.6%) did not have any of above-mentioned people. Two hundred eighteen participants (73.2%) reported that their friends, relatives, neighbors, or coworkers received a tornado threat information (watch/warning) and took protective action; however, 79 participants (26.5%) did not have any of the people mentioned above. Two hundred thirty-two participants (77.9%) reported that they have ever been exposed to media reports about tornadoes that have occurred in other places; however, 65 participants (21.8%) did not have been exposed to it.

Life experience. One hundred fifty-four participants (51.7%) reported that they have ever experienced a vehicle accident; however, 143 participants (48.0%) did not experience a vehicle accident. One hundred eighty-three participants (61.4%) reported that they have ever experienced an infrastructure failure (e.g., power, telecommunication); however, 114 participants (38.3%) did not experience an infrastructure failure. Forty-one participants (13.8%) reported that they have ever experienced an industrial hazard accident; however, 253 participants (84.9%) did not experience an industrial hazard accident. One hundred sixteen participants (38.9%) reported that they have ever experienced a severe health issue (e.g., illness, surgery, hospitalization); however, 180 participants (60.4%) did not experience a critical health issue. One hundred participants (33.6%) reported that they have ever experienced any other type of personal accident (e.g., crime, fire, traumatic event); however, 197 participants (66.1%) did not experience any other kind of personal disaster.

4.2. Experiment Results on Information Search

Repeated Measures ANOVA was used to answer RQ1 (*What is the most preferred tornado risk information among the five information displays (gradient polygon only, gradient polygon plus location, gradient polygon plus tornado track-line, gradient polygon plus tornado strike probability, and gradient polygon plus radar image*))? Each tornado risk information display's total click count is used to answer this research question. The results are presented in Table 1. Participants' click counts of five types of risk information are significantly different across groups (*Wilks' Lambda* = .93; $F_{(4, 294)}$ = 5.29, p <.01). Figure 4 shows that the mean for the *polygon only* click count is greater (1.39) than the *polygon plus location* click count (1.37). *Polygon plus track-line* information (1.23) was the least used among five types of risk information display.

Table 1. The mean of tornado risk information display total click counts (n=298)

Risk Information Display	Mean	Std. Deviation
Polygon only	1.39	1.14
Polygon plus location	1.37	1.22
Polygon plus tornado track line	1.23	1.43
Polygon plus tornado strike probability	1.28	.94
Polygon plus radar image	1.27	1.41

Wilks' Lambda = .93; $F_{(4, 294)}$ = 5.29, p<.01

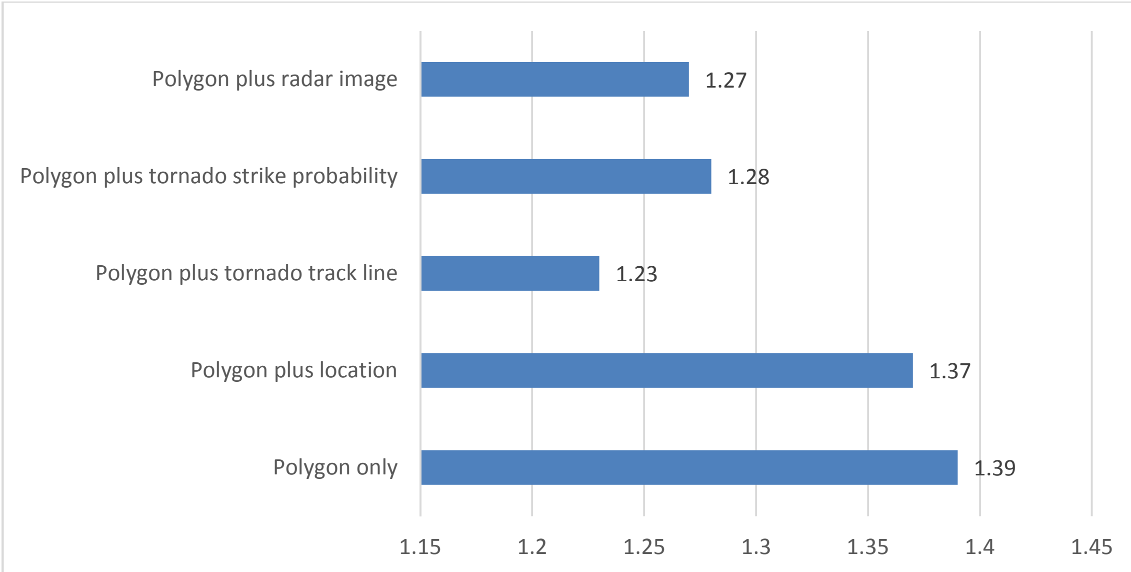


Figure 4. The mean of tornado risk information displays total click counts

Also, table 2 shows that participants' click duration of five types of information is significantly different across groups (*Wilks' Lambda* = .76; $F_{(4, 294)}$ = 23.71, p<.01). Figure 5 shows that the mean for the *Polygon plus radar image* click duration is higher (2.28) than the *Polygon plus tornado strike probability* click duration (1.99). Besides, *polygon plus radar image* and *polygon plus tornado strike probability* information (1.2336) were the higher among five types of risk information.

Table 2. The mean of tornado risk information display total click durations (n=298)

Risk Information Display	Mean	Std. Deviation
Polygon only	1.45	1.25
Polygon plus location	1.56	1.39
Polygon plus tornado track line	1.26	1.24
Polygon plus tornado strike probability	1.99	2.97
Polygon plus radar image	2.28	2.15

Wilks' Lambda = .76; $F_{(4, 294)}$ = 23.71, p<.01

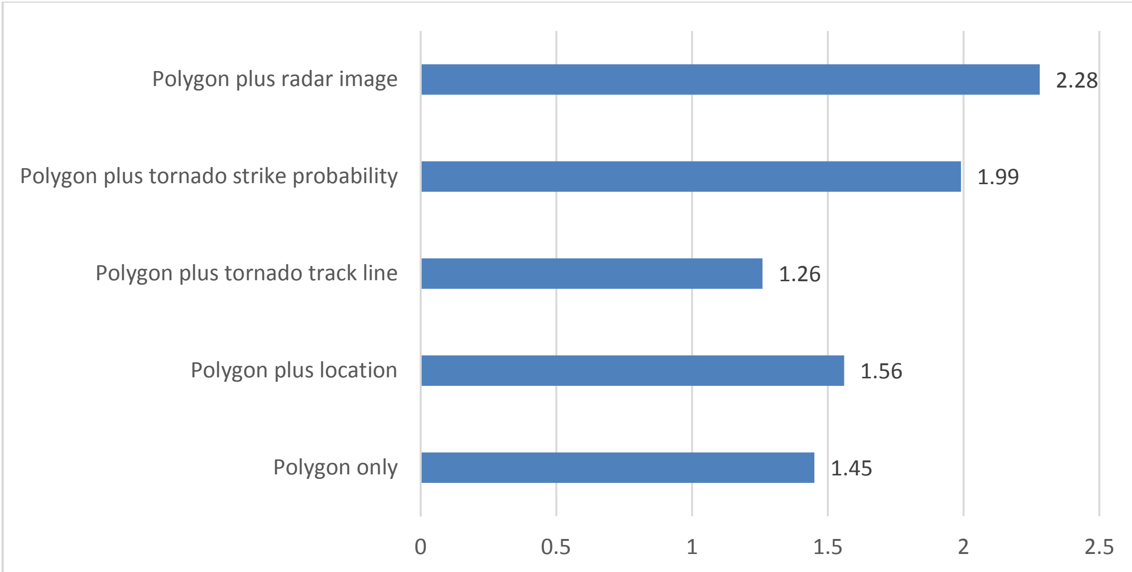


Figure 5. The mean of tornado risk information displays total click durations

Two-factor mixed-design ANOVA was used to answer RQ2 (*Will participants have different tornado information preferences for different tornado alert types such as watch and warning*). Table 3 shows participants' risk information display click counts are significantly different across groups (*Wilks' Lambda* = .93; $F_{(4,\ 293)}$ = 5.30, p<.01); however, the interaction effect of the two factors such as risk information display and alert type are not significant in this model (*Wilks' Lambda* = .98; $F_{(4,\ 293)}$ = 1.26, *ns*).

Table 3. The mean of tornado risk information display total click counts by alert type

Risk Information display	Alert type	Mean	Std. Deviation	N
Polygon only	Watch	1.42	1.24	159
	Warning	1.35	1.01	139
	Total	1.39	1.14	298
Polygon plus location	Watch	1.40	1.42	159
	Warning	1.33	.95	139
	Total	1.37	1.22	298
Polygon plus tornado track line	Watch	1.27	1.78	159
	Warning	1.19	.87	139
	Total	1.23	1.43	298
Polygon plus	Watch	1.34	.97	159

tornado strike probability	Warning	1.21	.89	139
	Total	1.28	.94	298
Polygon plus Radar image	Watch	1.19	1.00	159
	Warning	1.37	1.77	139
	Total	1.27	1.41	298

Effect (risk information display): *Wilks' Lambda* = .93; $F_{(4, 293)}$ = 5.30, p<.01
Effect (risk information display * alert type): *Wilks' Lambda* = .98; $F_{(4, 293)}$ = 1.26, *ns*

Also, table 4 shows that participants' risk information display click duration are significantly different across groups (*Wilks' Lambda* = .76; $F_{(4, 293)}$ = 23.54, p<.01); however, the interaction effect of the two factors such as risk information display and alert type are not significant in this model (*Wilks' Lambda* = .99; $F_{(4, 293)}$ = .41, *ns*).

Table 4. The mean of tornado risk information display total click durations by alert type

Risk Information display	Alert type	Mean	Std. Deviation	N
Polygon only	Watch	1.40	1.12	159
	Warning	1.51	1.37	139
	Total	1.45	1.25	298
Polygon plus location	Watch	1.53	1.33	159
	Warning	1.60	1.45	139
	Total	1.56	1.39	298
Polygon plus tornado track line	Watch	1.25	1.32	159
	Warning	1.27	1.16	139
	Total	1.26	1.24	298
Polygon plus tornado strike probability	Watch	2.12	3.75	159
	Warning	1.85	1.67	139
	Total	1.99	2.97	298
Polygon plus Radar image	Watch	2.22	2.07	159
	Warning	2.34	2.25	139
	Total	2.28	2.15	298

Effect (risk information display): *Wilks' Lambda* = .76; $F_{(4, 293)}$ = 23.54, p<.01
Effect (risk information display * alert type): *Wilks' Lambda* = .99; $F_{(4, 293)}$ = .41, *ns*

Repeated measure ANOVA was used to answer RQ3 (*Will participants have different tornado information preferences for different advisory types (advisory 1, advisory 2, advisory 3, advisory 4, advisory 5*))? Each tornado risk information display's total click counts and click durations under different advisory types are used to answer this research question. The results are presented in Table 5. Participants' click counts of five types of risk information under advisory 1 are significantly different across groups (*Wilks' Lambda* = .86; $F_{(4, 294)} = 11.69$, $p<.01$). Figure 6 shows that the mean for the *polygon only* click count is greater (3.17) than the *polygon plus location* click count (2.68). *Polygon plus track-line* information (2.22) was the least in this experiment among five types of risk information display.

Table 5. The mean of tornado risk information display total click counts under advisory 1 (n=298)

Risk Information Display	Mean	Std. Deviation
Polygon only	3.17	3.01
Polygon plus location	2.68	2.64
Polygon plus tornado track line	2.22	2.46
Polygon plus tornado strike probability	2.26	2.45
Polygon plus radar image	2.56	6.09

Wilks' Lambda = .86; $F_{(4, 294)} = 11.69$, $p<.01$

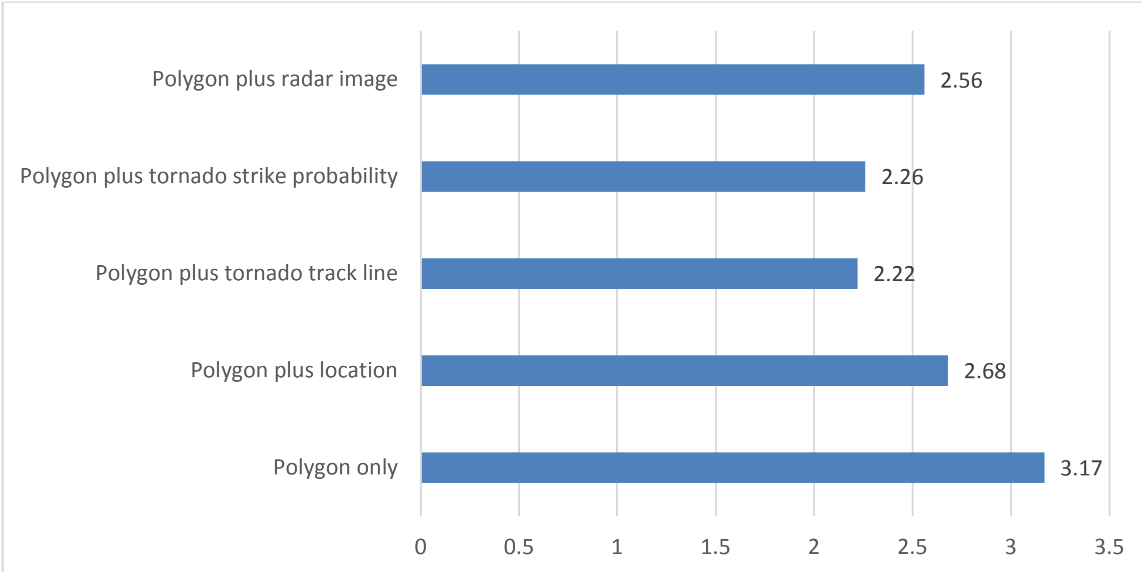


Figure 6. The mean of tornado risk information displays total click counts under advisory 1 (n=298)

Also, table 6 shows that participants' click duration of five types of risk information under advisory 1 is significantly different across groups (*Wilks' Lambda* = .79; $F_{(4, 294)}$ = 19.48, p<.01). Figure 7 shows that the mean for the polygon plus radar image click duration is higher (5.67) than the polygon plus tornado strike probability duration (3.83). *Polygon plus radar image* and *polygon plus tornado strike probability* information were the higher among five types of risk information.

Table 6. The mean of tornado risk information display total click durations under advisory 1 (n=298)

Risk Information Display	Mean	Std. Deviation
Polygon only	3.37	3.95
Polygon plus location	3.34	3.70
Polygon plus tornado track line	2.81	3.84
Polygon plus tornado strike probability	3.83	4.73
Polygon plus radar image	5.67	6.84

Wilks' Lambda = .79; $F_{(4, 294)}$ = 19.48, p<.01

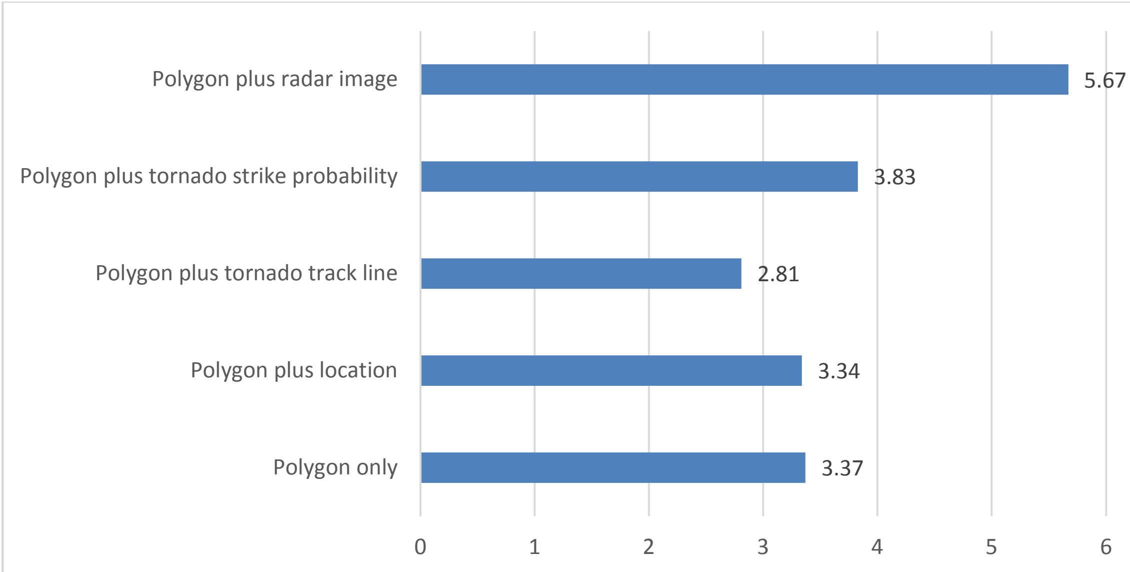


Figure 7. The mean of tornado risk information displays total click durations under advisory 1 (n=298)

Participants' click count of five types of risk information under advisory 2 are non-significantly different across groups (*Wilks' Lambda* = .99; $F_{(4, 294)}$ = .97, *ns*). Also, table 7 shows that participants' click duration of five types of risk information under advisory 2 is significantly different across groups (*Wilks' Lambda* = .86; $F_{(4, 294)}$ = 11.59, p<.01). Figure 8 shows that the mean for the *Polygon plus radar image* click duration is greater (2.26) than the *polygon plus tornado strike probability* duration (2.00). Besides, *polygon plus radar image* and *polygon plus tornado strike probability* information were the greater among five types of risk information.

Table 7. The mean of tornado risk information display total click durations under advisory 2 (n=298)

Risk Information Display	Mean	Std. Deviation
Polygon only	1.55	1.90
Polygon plus location	1.65	2.04
Polygon plus tornado track line	1.27	1.66
Polygon plus tornado strike probability	2.00	3.05
Polygon plus radar image	2.26	3.43

$Wilks' Lambda$ = .86; $F_{(4, 294)}$ = 11.59, p<.01

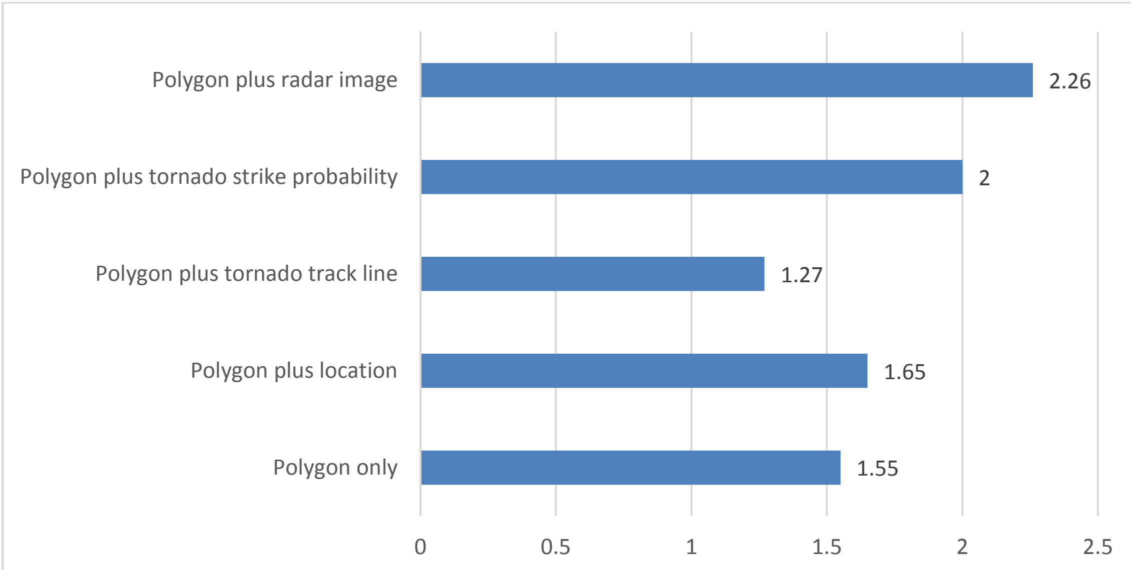


Figure 8. The mean of tornado risk information displays total click durations under advisory 2 (n=298)

Table 8 shows Participants' click count of five types of risk information under advisory 3 are significantly different across groups (*Wilks' Lambda* = .97; $F_{(4, 294)}$ = 2.41, p<.05). Figure 9 shows that the mean for the *polygon plus location* click count is higher (1.18) than the *polygon plus tornado strike probability* click count (1.14). *Polygon plus radar image* information (0.96) was the least in this experiment among five types of risk information display.

Table 8. The mean of tornado risk information display total click counts under advisory 3 (n=298)

Risk Information Display	Mean	Std. Deviation
Polygon only	1.03	2.11
Polygon plus location	1.18	3.21
Polygon plus tornado track line	1.10	2.70
Polygon plus tornado strike probability	1.14	1.30
Polygon plus radar image	0.96	0.93

$Wilks' Lambda$ = .97; $F_{(4, 294)}$ = 2.41, p<.05

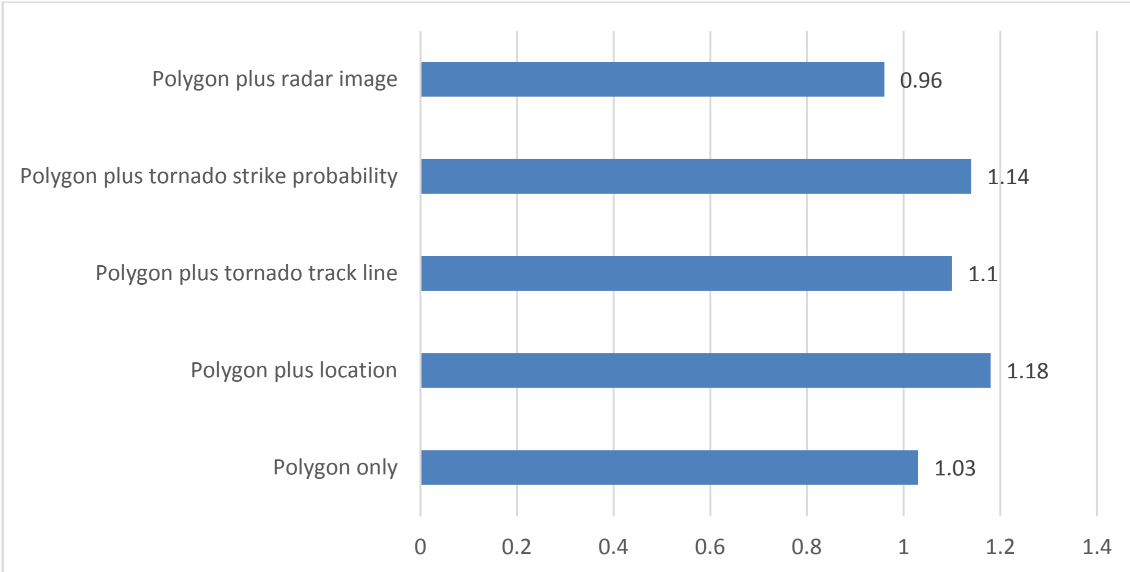


Figure 9. The mean of tornado risk information displays total click counts under advisory 3 (n=298)

Table 9 shows that participants' click duration of five types of risk information under advisory 3 is significantly different across groups (*Wilks' Lambda* = .92; $F_{(4, 294)} = 6.71$, $p<.01$). Figure 10 shows that the mean for the *Polygon plus tornado strike probability* click duration is higher (1.90) than the *Polygon plus radar image* click duration (1.59). Also, *polygon plus tornado strike probability* and *polygon plus radar image* information was the higher among five types of risk information.

Table 9. The mean of tornado risk information display total click durations under advisory 3 (n=298)

Risk Information Display	Mean	Std. Deviation
Polygon only	1.05	1.34
Polygon plus location	1.21	1.77
Polygon plus tornado track line	1.06	1.70
Polygon plus tornado strike probability	1.90	4.17
Polygon plus radar image	1.59	2.28

Wilks' Lambda = .92; $F_{(4, 294)} = 6.71$, $p<.01$

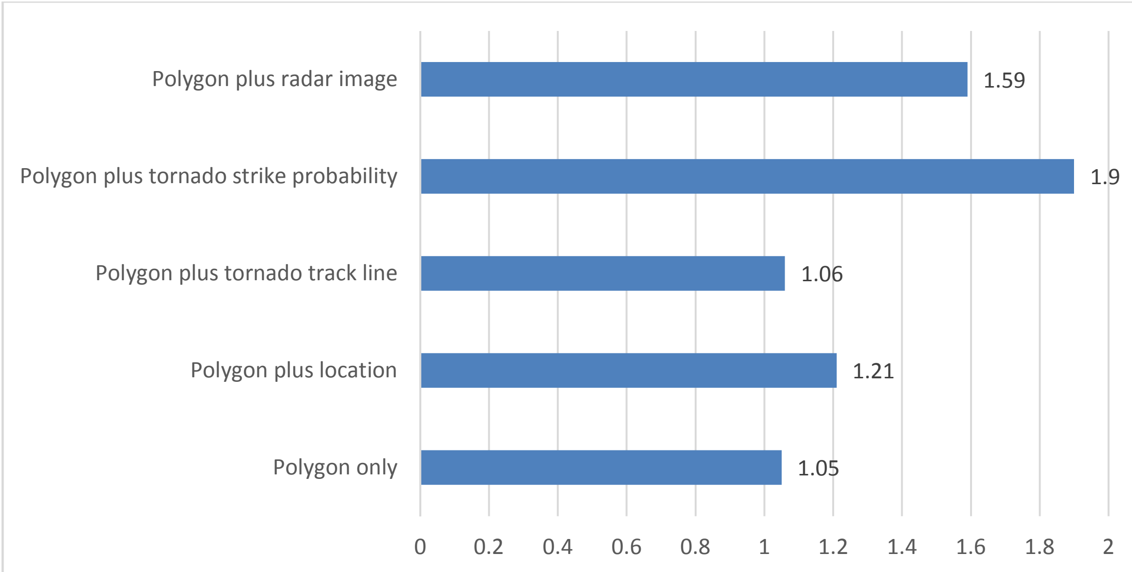


Figure 10. The mean of tornado risk information displays total click durations under advisory 3 (n=298)

Participants' click count of five types of risk information under advisory 4 are non-significantly different across groups (*Wilks' Lambda* = .98; $F_{(4, 294)}$ = 1.63, *ns*). Also, table 10 shows that participants' click duration of five types of risk information under advisory 4 is significantly different across groups (*Wilks' Lambda* = .93; $F_{(4, 294)}$ = 5.48, p<.01). Figure 11 shows that the mean for the *Polygon plus tornado strike probability* click duration is greater (1.19) than the *Polygon plus radar image* click duration (1.01). Also, *polygon plus tornado strike probability* and *polygon plus radar image* information was the greater among five types of risk information.

Table 10. The mean of tornado risk information display total click durations under advisory 4 (n=298)

Risk Information Display	Mean	Std. Deviation
Polygon only	.61	.74
Polygon plus location	.77	1.15
Polygon plus tornado track line	.64	1.00
Polygon plus tornado strike probability	1.19	3.94
Polygon plus radar image	1.01	1.93

Wilks' Lambda = .93; $F_{(4, 294)}$ = 5.48, p<.01

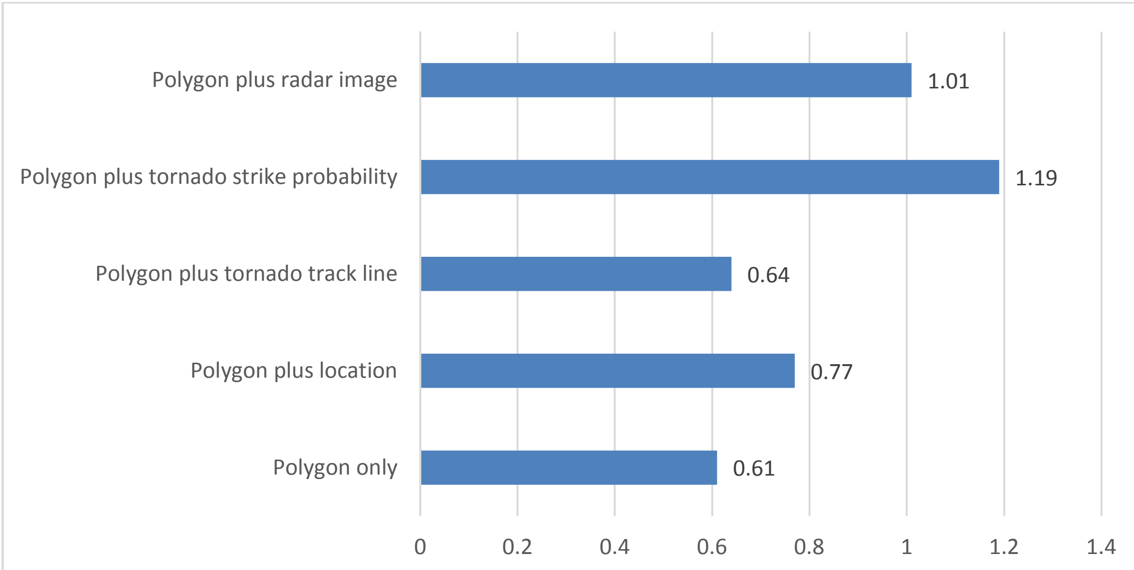


Figure 11. The mean of tornado risk information displays total click durations under advisory 4 (n=298)

Table 11 shows that participants' click count of five types of risk information under advisory 5 are significantly different across groups (*Wilks' Lambda* = .94; $F_{(4, 294)}$ = 4.56, p<.01). Figure 12 shows that the mean for the *polygon plus tornado strike probability* click count is higher (.77) than the *polygon plus location* click count (.74). *Polygon only* information (.59) was the least in this experiment among five types of risk information display.

Table 11. The mean of tornado risk information display total click counts under advisory 5 (n=298)

Risk Information Display	Mean	Std. Deviation
Polygon only	.59	.70
Polygon plus location	.74	.78
Polygon plus tornado track line	.63	.70
Polygon plus tornado strike probability	.77	.87
Polygon plus radar image	.69	1.00

Wilks' Lambda = .94; $F_{(4, 294)}$ = 4.56, p<.01

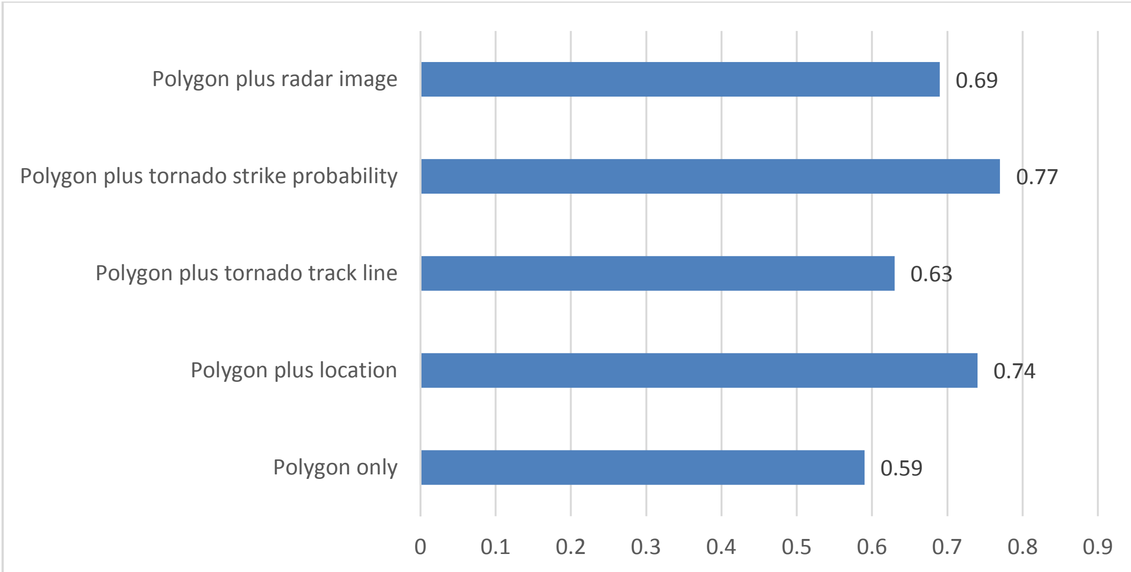


Figure 12. The mean of tornado risk information displays total click counts under advisory 5 (n=298)

Table 12 shows that participants' click duration of five types of risk information under advisory 5 is significantly different across groups (*Wilks' Lambda* = .91; $F_{(4, 294)} = 6.90$, $p<.01$). Figure 13 shows that the mean for the *Polygon plus tornado strike probability* click duration is higher (1.06) than the *Polygon plus radar image* click duration (.86). In addition, *polygon plus tornado strike probability* and *polygon plus radar image* information was the higher among five types of risk information.

Table 12. The mean of tornado risk information display total click durations under advisory 5 (n=298)

Risk Information Display	Mean	Std. Deviation
Polygon only	.67	.99
Polygon plus location	.82	1.51
Polygon plus tornado track line	.50	.81
Polygon plus tornado strike probability	1.06	3.56
Polygon plus radar image	.86	1.77

Wilks' Lambda = .91; $F_{(4, 294)} = 6.90$, $p<.01$

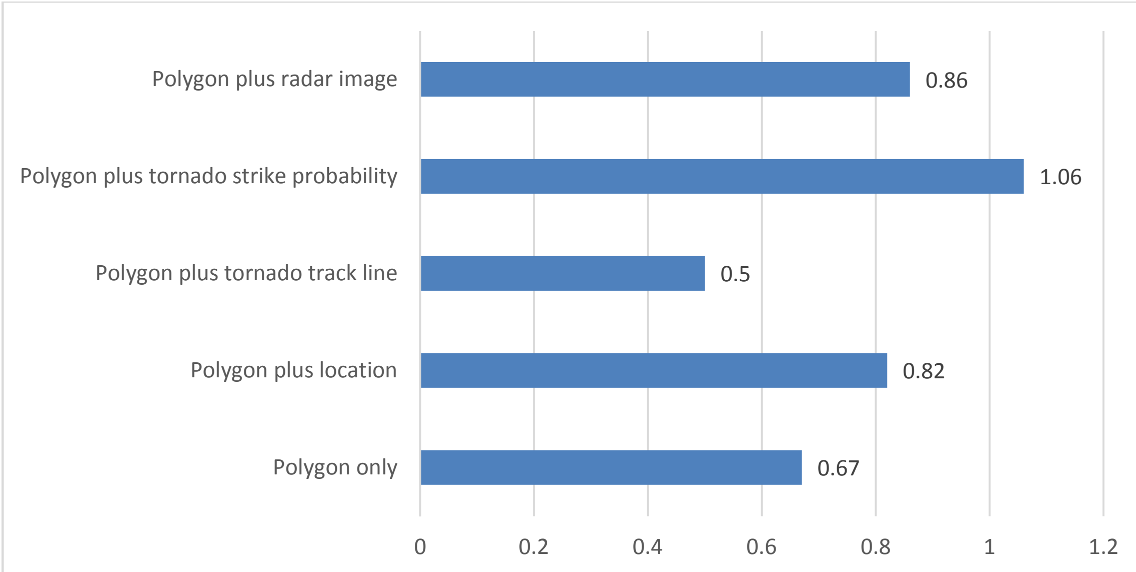


Figure 13. The mean of tornado risk information displays total click durations under advisory 5 (n=298)

ANCOVA was used to answer RQ4 (*Do international and domestic student participants have different tornado information preferences after controlling for demographic characteristics?*). The analyses show Levene's test results are significant (p <.05), indicating that the homogeneity of variance assumption has been violated. However, according to Keppel, Saufley, and Tokunaga (1992), Levene's test can be ignored if the sample size for each group is relatively similar.

To test this research question, the researcher used eight ANCOVA analyses to examine the differences between international and domestic students' tornado risk information preferences (total click counts of gradient polygon only, gradient polygon plus location, gradient polygon plus track-line, gradient polygon plus tornado strike probability, and gradient polygon plus radar image). The results of ANCOVA indicate none of the demographic variables have impact on domestic and international students' information preference. However, the two groups have significant different tornado information preferences ($F_{(1, 292)} = 5.14$, $p<.05$). Table 13 shows the means of overall click counts of the international and domestic students. Figure 14 shows that the mean value of international and domestic students' total click counts is 7.59 and 5.91, which indicates international students have significantly higher tornado information preference comparing domestic students.

Table 13. The means of overall click counts between international and domestic student when controlling for demographic variables[1]

Student type	Mean	Std. Deviation
International	7.59	7.60
Domestic	5.91	2.26

Covariate(age): $F_{(1, 292)} = 1.81$, *ns*
Covariate(sex): $F_{(1, 295)} = 2.75$, *ns*
Covariate(marital status): $F_{(1, 295)} = .90$, *ns*
Covariate(white/non-white): $F_{(1, 294)} = .01$, *ns*
Covariate(education): $F_{(1, 295)} = 2.40$, *ns*
Covariate(family income): $F_{(1, 292)} = 3.08$, *ns*
Covariate(rental status): $F_{(1, 294)} = .03$, *ns*
Covariate(on-campus/university housing): $F_{(1, 293)} = .81$
Main effect: $p < .05$

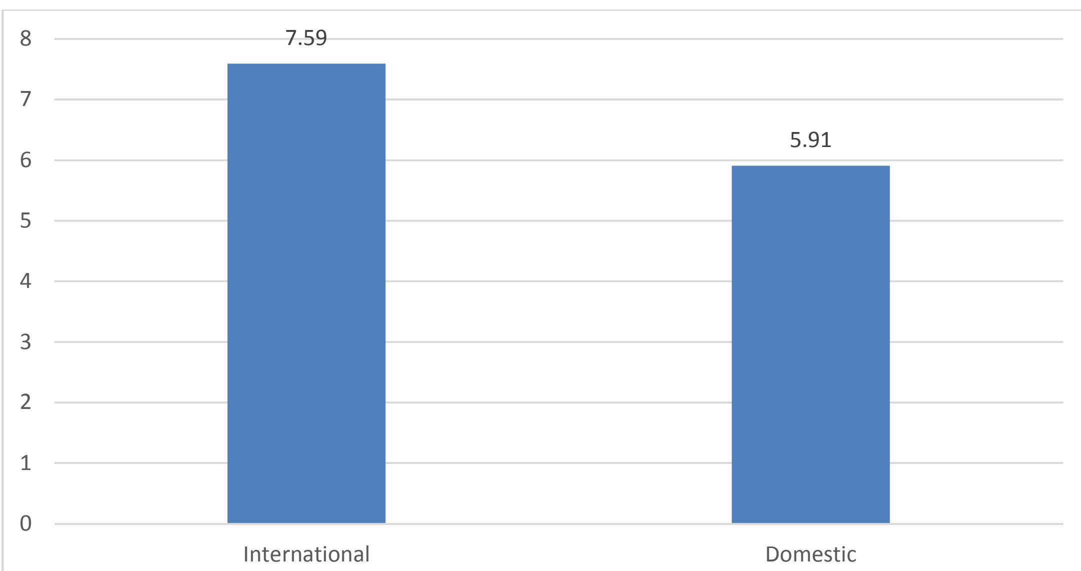


Figure 14. The means of overall click counts between international and domestic student

[1] Eight ANCOVA analysis were used. Table 13 shows all the statistics for the non-significant covariates. While the F-values are different, the main effects (type of students) are significant at .05 level.

Correlation analysis was used to answer RQ5 (*What are the correlation among information search and demographic variables?*); the results are presented in Table 14. *Age* is positively correlated with *total click counts* (r = .13, p < .05). This result shows the older students are more likely to pay attention to risk information. *Family income* is negatively correlated with *total click counts* (r = -.15, p < .05) and *total click duration* (r = -.12, p < .05). This result shows the higher income family students are less likely to pay attention to risk information.

Table 14. Correlations among information search, age, and family income level

Variables	1	2	3	4
1.Total click count	-			
2.Total click duration	.43**	-		
3.Age	.13*	.06	-	
4.Family income	-.15**	-.12*	-.31**	-

**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed)

4.3. Experience on the experiment RQs

Repeated Measures ANOVA was used to answer EERQ1 (*What is the most preferred tornado risk information among the risk information displays (gradient polygon only, gradient polygon plus location, gradient polygon plus tornado track-line, gradient polygon plus tornado strike probability, and gradient polygon plus radar image*))? Participants' self-reported preference for risk information display in this experiment is used to answer this research question. The results are presented in Table 15. Each preference of risk information display are significantly different across groups (*Wilks' Lambda* = .68; $F_{(4, 293)}$ = 35.17, p<.01). Figure 15 shows that the mean for the self-reported preference of the *polygon plus tornado strike probability* is greater (3.86) than *polygon plus radar image* (3.74). *Polygon only* information (3.06) was the least preferred among five types of risk information display.

Table 15. The mean of self-reported risk information preference (n=297)

Risk Information Display	Mean	Std. Deviation
Polygon only	3.06	1.15
Polygon plus location	3.56	1.11
Polygon plus tornado track line	3.43	1.12
Polygon plus tornado strike probability	3.86	1.13
Polygon plus radar image	3.74	1.22

Wilks' Lambda = .68; $F_{(4, 293)}$ = 35.17, p<.01

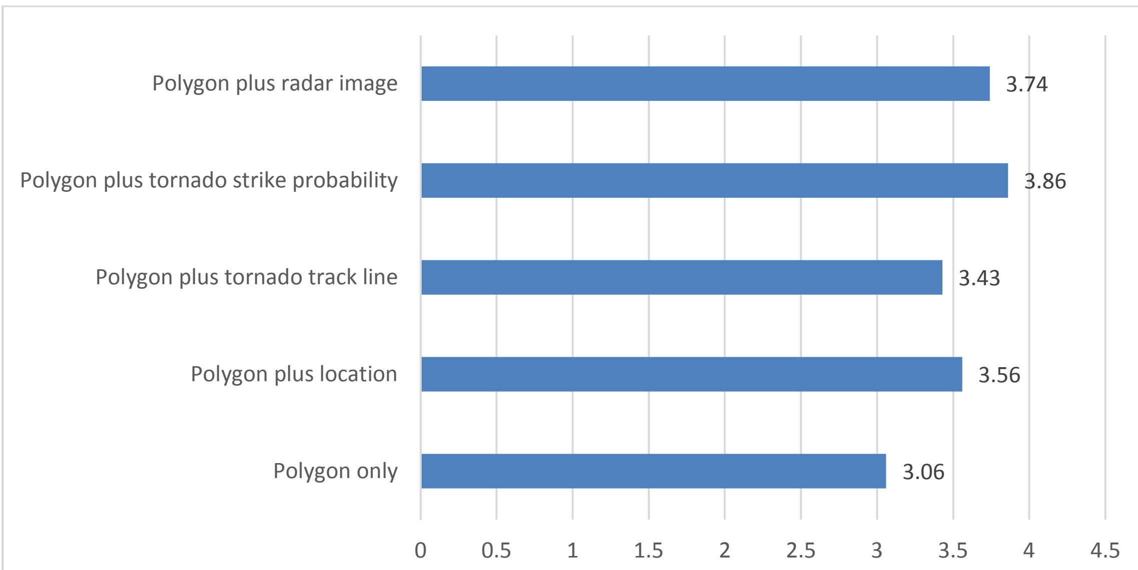


Figure 15. The mean of self-reported risk information preference (n=297)

4.4. Results on risk perception

ANCOVA was used to answer RPRQ1 (*Do international and domestic student participants have different tornado risk perceptions after controlling for demographic characteristics?*). Since this study has eight demographic variables, eight ANCOVA analysis were used to test this research question. The results are reported below. The analysis shows Levene's test result is not significant ($F_{(1, 293)}$ = .00, *ns*), indicating that the homogeneity of variance assumption is not violated. The results of ANCOVA indicate seven variables of the demographic variables except age have not impacted on domestic and international students' risk perceptions. However, Table 16 shows the two groups have significantly different tornado risk perception ($F_{(1, 292)}$ = 5.63, p<.05). Figure 16 shows the mean value of international and domestic students' risk perception is 3.66 and 3.46, which indicates international students have significantly higher tornado risk precautions comparing domestic students.

Table 16. The means of tornado risk perceptions between international and domestic student when controlling for demographic variables[2]

Student type	Mean	Std. Deviation
International	3.66	.74
Domestic	3.46	.72

Covariate(age): $F_{(1, 292)}$ = .48, *ns*
Covariate(marital status): $F_{(1, 295)}$ = .00, *ns*
Covariate(ethnicity): $F_{(1, 294)}$ = 1.90, *ns*
Covariate(education): $F_{(1, 295)}$ = .91, *ns*
Covariate(family income): $F_{(1, 292)}$ = 3.25, *ns*
Covariate(rental status): $F_{(1, 294)}$ = .03, *ns*
Covariate(on-campus/university housing): $F_{(1, 293)}$ = 1.96, *ns*
Main effect: p <.05

[2] Eight ANCOVA analysis were used. Table 16 shows all the statistics for the non-significant covariates. While the F-values are different, the main effects (type of students) are significant at .05 level.

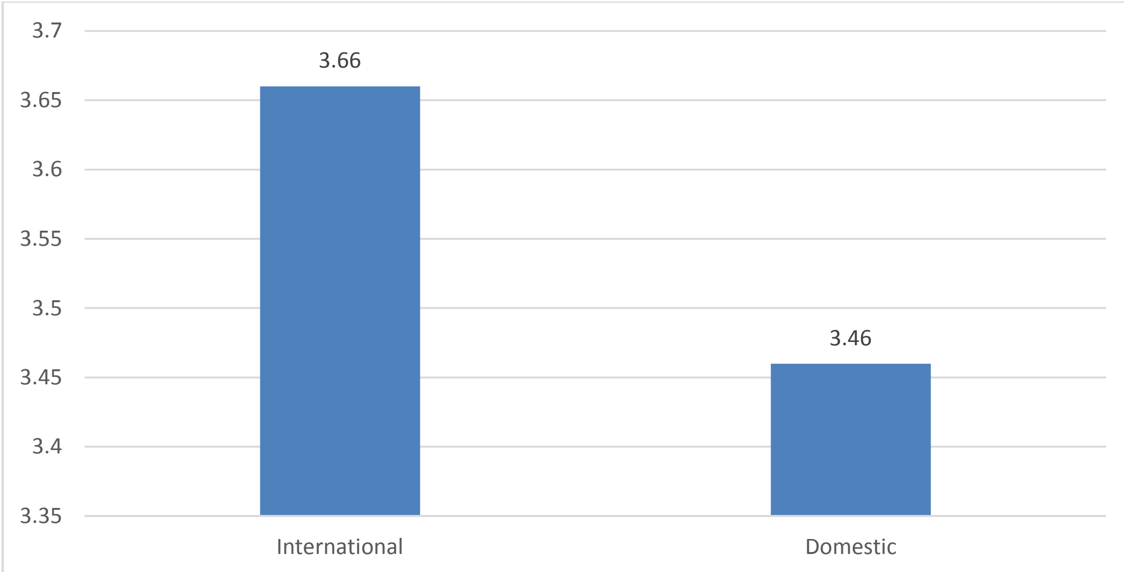


Figure 16. The means of tornado risk perceptions between international and domestic student when controlling for demographic variables

The results of ANCOVA indicate that age impacted domestic and international students' risk perceptions ($F_{(1, 295)}$ = 4.96, *p* <.05). The results are presented in Table 17. Levene's test is not significant ($F_{(1, 296)}$ = .00, *ns*), indicating that the homogeneity of variance assumption has not been violated. This finding suggests domestic and international students' risk perception difference after control for age. As indicated in Table 17, domestic and international students have different tornado risk perceptions after viewing the tornado risk information search screen after control for sex ($F_{(1, 295)}$ = 7.48, *p* <.05). Figure 17 shows the estimated means of risk perception of international and domestic students. These estimated marginal means are adjusted by controlling for participants' sex. Table 18 shows that the mean value of international and domestic students' risk perception is 3.69 and 3.45, which indicates international students have significantly higher tornado risk precautions comparing domestic students.

Table 17. The estimated marginal (EM) means of tornado risk perceptions between international and domestic student when controlling for sex

Student type	Adjusted Mean	EM Mean	Std. Error
International	3.66	3.69	.07
Domestic	3.46	3.45	.05

Covariate(sex): $F_{(1, 295)} = 4.96$, $p < .05$
Main effect: $F_{(1, 295)} = 7.48$, $p < .05$

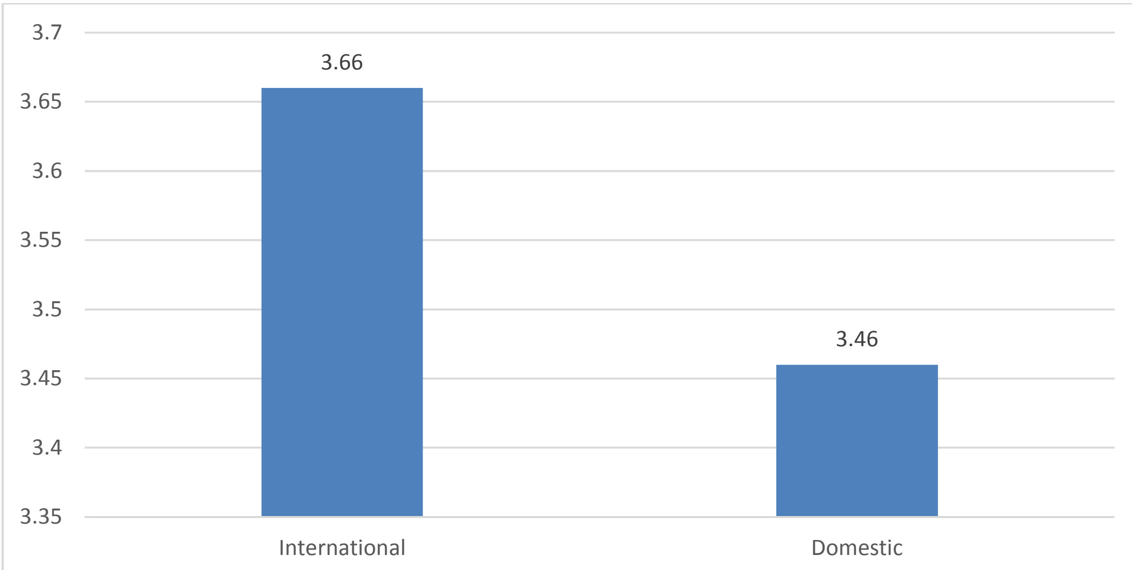


Figure 17. The estimated marginal (EM) means of tornado risk perceptions between international and domestic student when controlling for sex

Independent-sample t-test were used to answer RPRH1 (*Participants who are assigned to tornado watch groups and participants who are assigned to tornado warning group have different risk perceptions after viewing the first advisory*). The Cronbach's alpha for the overall scale of four questions is .85, which indicates the risk perception questions can be combined into one risk perception index. The independent sample t-test results are presented in Table 18. Levene's test is not significant ($F_{(296)} = 1.70$, *ns*), indicating that the homogeneity of variance assumption has not been violated. The mean rating of risk perception between watch group and warning group is different ($t_{(296)} = -2.13$, $p<.05$). Figure 18 shows that the mean value of the watch and warning group's risk perception is 2.85 and 3.10, which indicates the warning group has significantly higher tornado risk precautions comparing the watch group.

Table 18. The mean of Advisory 1 risk perception by alert group

Alert type	Mean	Std. Deviation
Watch	2.85	.97
Warning	3.10	1.03

Advisory 1 risk perception: $t_{(296)} = -2.13$, $p < .05$

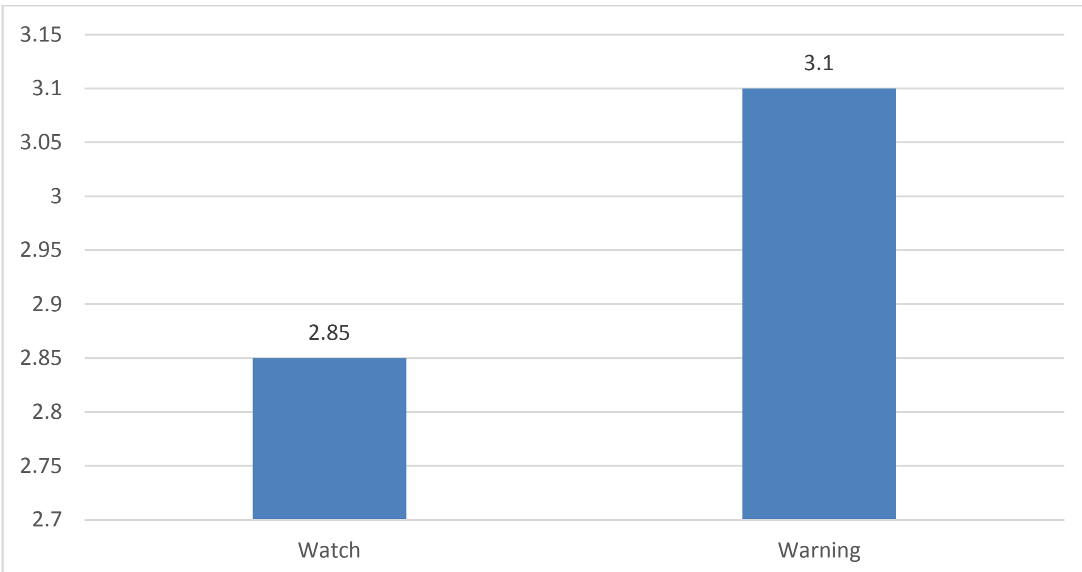


Figure 18. The mean of Advisory 1 risk perception by alert group

Independent-sample t-test were used to answer RPRH2 *(Participants who are assigned to tornado watch groups and participants who are assigned to tornado warning groups have different risk perceptions after viewing the second advisory*). The Cronbach's alpha for the overall scale of four questions is.87, which indicates the risk perception questions can be combined into one risk perception index. The results are presented in Table 19. Levene's test is not significant ($F_{(296)} = .99$, *ns*), indicating that the homogeneity of variance assumption has not been violated. The mean rating of risk perception between watch group and warning group is different ($t_{(296)} = -2.17$, $p < .05$).

Figure 19 shows that the mean value of the watch and warning group's risk perception is 2.95 and 3.20, which indicates the warning group has significantly higher tornado risk precautions comparing the watch group.

Table 19. The mean of Advisory 2 risk perception by alert group

Alert type	Mean	Std. Deviation
Watch	2.95	1.04
Warning	3.20	.99

Advisory 2 risk perception: $t_{(296)} = -2.17$, $p < .05$

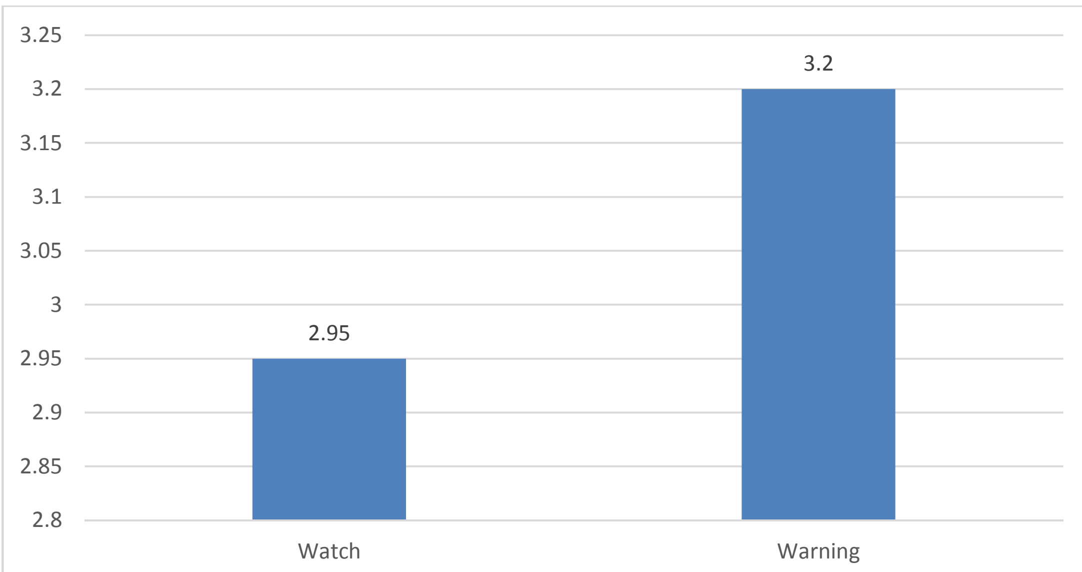


Figure 19. The mean of Advisory 2 risk perception by alert group

Independent-sample t-test were used to answer RPRH3 (*Participants who are assigned to tornado watch groups and participants who are assigned to tornado warning groups have different risk perceptions after viewing the third advisory*). The Cronbach's alpha for the overall scale of four questions is 86, which indicates that the risk perception questions can be combined into one risk perception index. The results are presented in Table 20. Levene's test is not significant ($F_{(296)} = .83$, *ns*), indicating that the homogeneity of variance assumption has not been violated. The mean rating of risk perception between watch the group and warning group is different ($t_{(296)} = -2.19$, $p<.05$). Figure 20 shows that the mean value of the watch and warning group's risk perception is 3.36 and 3.61, which indicates that the warning group has significantly higher tornado risk precautions comparing the watch group.

Table 20. The mean of Advisory 3 risk perception by alert group

Alert type	Mean	Std. Deviation
Watch	3.36	1.00
Warning	3.61	.93

Advisory 3 risk perception: $t_{(296)} = -2.19$, $p<.05$

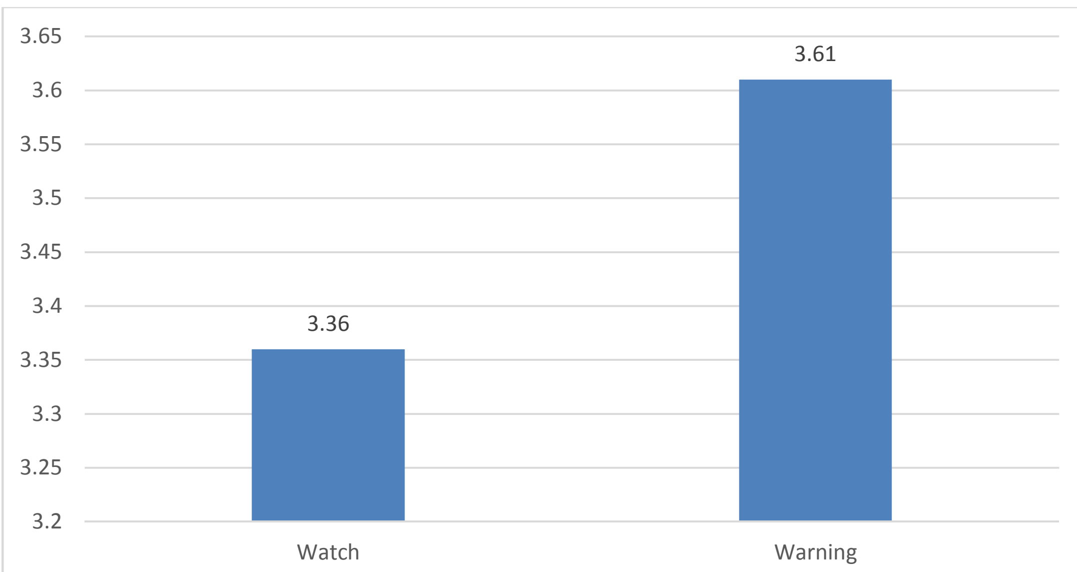


Figure 20. The mean of Advisory 3 risk perception by alert group

Independent-sample t-test were used to answer RPRH4 (Participants who are assigned to tornado watch groups and participants who are assigned to tornado warning groups have different risk perceptions after viewing the fourth advisory). The Cronbach's alpha for the overall scale of four questions is .89, which indicates that the risk perception questions can be combined into one risk perception index. The results are presented in Table 21. Levene's test is not significant ($F_{(296)}$ = .40, *ns*), indicating that the homogeneity of variance assumption has not been violated. The mean rating of risk perception between watch group and warning group are not significantly different ($t_{(296)}$ = -1.96, *ns*). Figure 21 shows that the mean value of the watch and warning group's risk perception is 3.81 and 4.04, which indicates that the warning group has significantly higher tornado risk precautions comparing the watch group.

Table 21. The mean of Advisory 4 risk perception by alert group

Alert type	Mean	Std. Deviation
Watch	3.81	1.03
Warning	4.04	.96

Advisory 4 risk perception: $t_{(296)}$ = -1.96, *ns*

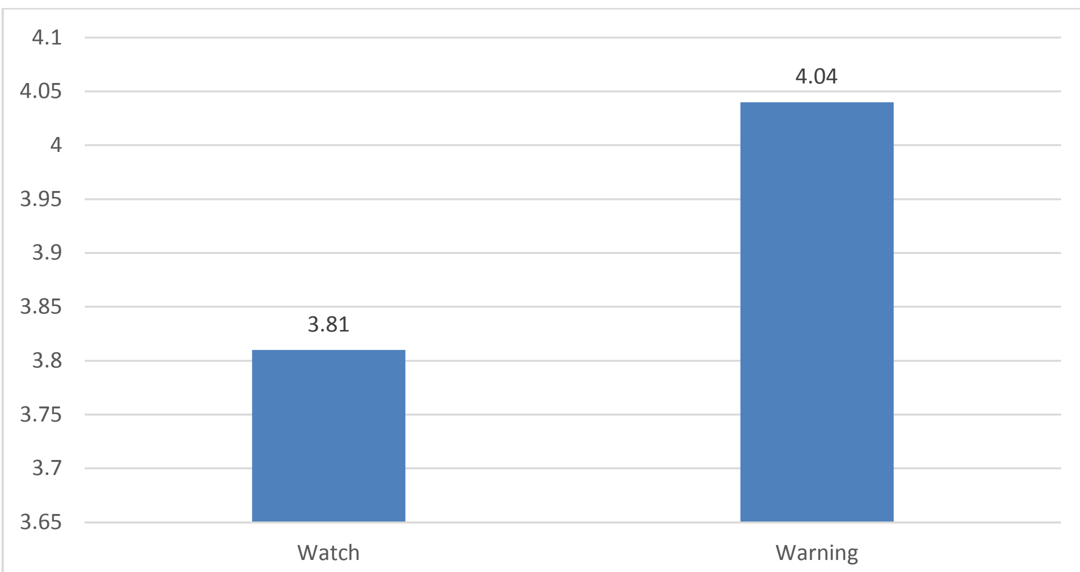


Figure 21. The mean of Advisory 4 risk perception by alert group

Independent-sample t-test were used to answer RPRH5 (*Participants who are assigned to tornado watch groups and participants who are assigned to tornado warning* *groups have different risk perceptions after viewing the fifth advisory*). The Cronbach's alpha for the overall scale of four questions is .89, which indicates that the risk perception questions can be combined into one risk perception index. The results are presented in Table 22. Levene's test was not significant ($F_{(296)}$ = 6.20, *ns*), indicating that the homogeneity of variance assumption has not been violated. The mean rating of risk perception between watch group and warning group are significantly different ($t_{(296)}$ = -2.37, p<.05). Figure 22 shows that the mean value of the watch and warning group's risk perception is 4.14 and 4.40, which indicates that the warning group have significantly higher tornado risk precautions comparing the watch group.

Table 22. The mean of Advisory 5 risk perception by alert group

Alert type	Mean	Std. Deviation
Watch	4.14	1.04
Warning	4.40	.80

Advisory 5 risk perception: $t_{(296)}$ = -2.37, p <.05

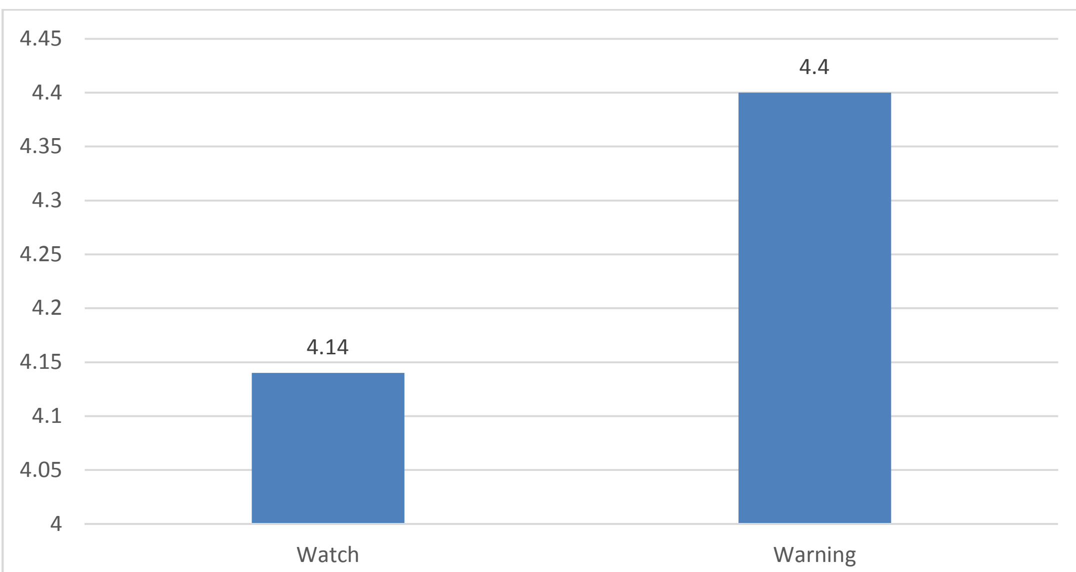


Figure 22. The mean of Advisory 5 risk perception by alert group

Correlation analysis was used to answer RPRQ2 (*What are the correlation among information search and demographic variables?*); the results are presented in Table 23. Risk perception is not significantly correlated with age (r = .00, *ns*) and family income (r = .05, *ns*).

Table 23. Correlations among risk perception, age, and family income level

Variables	1	2	3
1.Risk perception	-		
2.Age	.00	-	
3.Family income	.05	$-.31^{**}$	-

**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed)

4.5. Protective Action RQs and RHs

Two-factor mixed-design ANOVA was used to answer PARQ1 (*Do international and domestic student participants have different protective action selection under Advisory 1?*). Table 24 shows participants' protective action selection under advisory 1 are significantly different across student type (*Wilks' Lambda* = .24; $F_{(6, 284)}$ = 149.97, p<.01); the interaction effect of the two factors are significant in this model (*Wilks' Lambda* = .67; $F_{(6, 284)}$ = 23.83, p<.01). Figure 23 shows that international and domestic students take different protective actions when it comes to tornado watches or warnings. First, domestic students (2.69) are more likely to ignore a tornado watch/warning and continue what they were doing than international students (2.47). Second, international students (4.08) are more likely to protect or secure their private property than domestic students (4.07). Third, domestic students (4.39) are more likely to monitor TV or radio than international students (3.63). Fourth, domestic students (3.35) are more likely to stay home and move to an interior room in the home than international students (3.14). Fifth, international students (3.04) are more likely to leave home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family house than domestic students (2.65). Sixth, international students (3.12) are more likely to leave home and take shelter at a public tornado shelter than domestic students (1.88). Seventh, international students (1.98) are more likely to leave home with no destination in mind, to get out of the path of the tornado than domestic students (1.36).

Table 24. The mean of advisory 1 protective action selection by student type

Protective Action Selection	Student type	Mean	Std. Deviation	N
Advisory 1 Q5	International	2.47	1.33	107
	Domestic	2.69	1.18	184
	Total	2.61	1.24	291
Advisory 1 Q6	International	4.08	1.17	107
	Domestic	4.07	1.10	184
	Total	4.07	1.12	291
Advisory 1 Q7	International	3.63	1.18	107
	Domestic	4.39	.92	184
	Total	4.11	1.08	291
Advisory 1 Q8	International	3.14	1.29	107
	Domestic	3.35	1.13	184
	Total	3.27	1.19	291
Advisory 1 Q9	International	3.04	1.39	107
	Domestic	2.65	1.38	184
	Total	2.79	1.40	291
Advisory 1 Q10	International	3.12	1.39	107
	Domestic	1.88	1.11	184
	Total	2.34	1.36	291
Advisory 1 Q11	International	1.98	1.27	107
	Domestic	1.36	.74	184
	Total	1.59	1.01	291

Effect (advisory 1 protective action): *Wilks' Lambda* = .24; $F_{(6, 284)}$ = 149.97, p<.01
Effect (advisory 1 protective action * student type): *Wilks' Lambda* = .67; $F_{(6, 284)}$ = 23.83, p<.01

When a tornado watch/warning is issued, what is your response?
Q5 = Ignore/continue what I am doing, Q6 = Protect/secure private property Q7 = Monitor TV or radio, Q8 = Stay home and move to an interior room in the home, Q9 = Leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house, Q10 = Leave my home and take shelter at a public tornado shelter, Q11 = Leave my home with no destination in mind, simply to get out of the path of the tornado

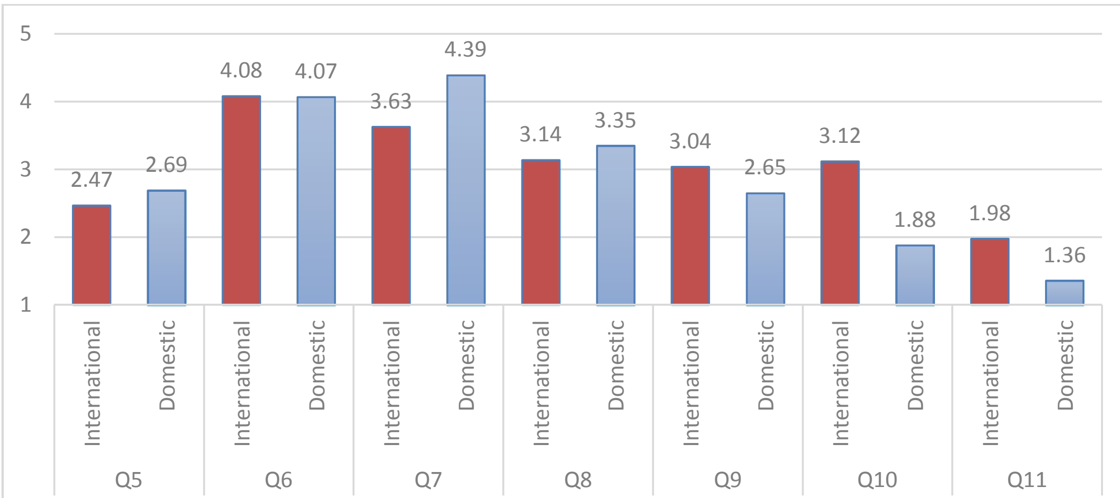


Figure 23. The mean of advisory 1 protective action selection by student type

Also, Table 25 shows participants' protective action selection under advisory 2 are significantly different across student type (*Wilks' Lambda* = .30; $F_{(6, 281)}$ = 110.20, p<.01); the interaction effect of the two factors are significant in this model (*Wilks' Lambda* = .71; $F_{(6, 281)}$ = 19.37, p <.01). Figure 24 shows that international and domestic students take different protective actions against tornado watches or warnings. First, international students (2.56) are more likely to ignore it and continue what they were doing than domestic students (2.43). Second, domestic students (4.07) are more likely to protect or secure their private property than international students (3.97). Third, domestic students (4.45) are more likely to monitor TV or radio than international students (3.62). Fourth, domestic students (3.58) are more likely to stay home and move to an interior room in the home than international students (3.43). Fifth, international students (3.07) are more likely to leave home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family house than domestic students (2.89). Sixth, international students (3.21) are more likely to leave home and take shelter at a public tornado shelter than domestic students (2.18). Seventh, international students (2.12) are more likely to leave home with no destination in mind, to get out of the path of the tornado than domestic students (1.45).

Table 25. The mean of advisory 2 protective action selection by student type

Protective Action Selection	Student type	Mean	Std. Deviation	N
Advisory 2 Q5	International	2.56	1.33	106
	Domestic	2.43	1.20	182
	Total	2.48	1.25	288
Advisory 2 Q6	International	3.97	1.09	106
	Domestic	4.07	1.07	182
	Total	4.03	1.08	288
Advisory 2 Q7	International	3.62	1.14	106
	Domestic	4.45	.91	182
	Total	4.15	1.08	288
Advisory 2 Q8	International	3.43	1.25	106
	Domestic	3.58	1.21	182
	Total	3.52	1.22	288
Advisory 2 Q9	International	3.07	1.35	106
	Domestic	2.89	1.39	182
	Total	2.95	1.38	288
Advisory 2 Q10	International	3.21	1.33	106
	Domestic	2.18	1.24	182
	Total	2.56	1.37	288
Advisory 2 Q11	International	2.12	1.27	106

Domestic	1.45	.89	182
Total	1.69	1.09	288

Effect (advisory 2 protective action): *Wilks' Lambda* = .30; $F_{(6, 281)}$ = 110.20, p<.01

Effect (advisory 2 protective action * student type): *Wilks' Lambda* = .71; $F_{(6, 281)}$ = 19.37, p<.01

When a tornado watch/warning is issued, what is your response?

Q5 = Ignore/continue what I am doing, Q6 = Protect/secure private property Q7 = Monitor TV or radio, Q8 = Stay home and move to an interior room in the home, Q9 = Leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house, Q10 = Leave my home and take shelter at a public tornado shelter, Q11 = Leave my home with no destination in mind, simply to get out of the path of the tornado

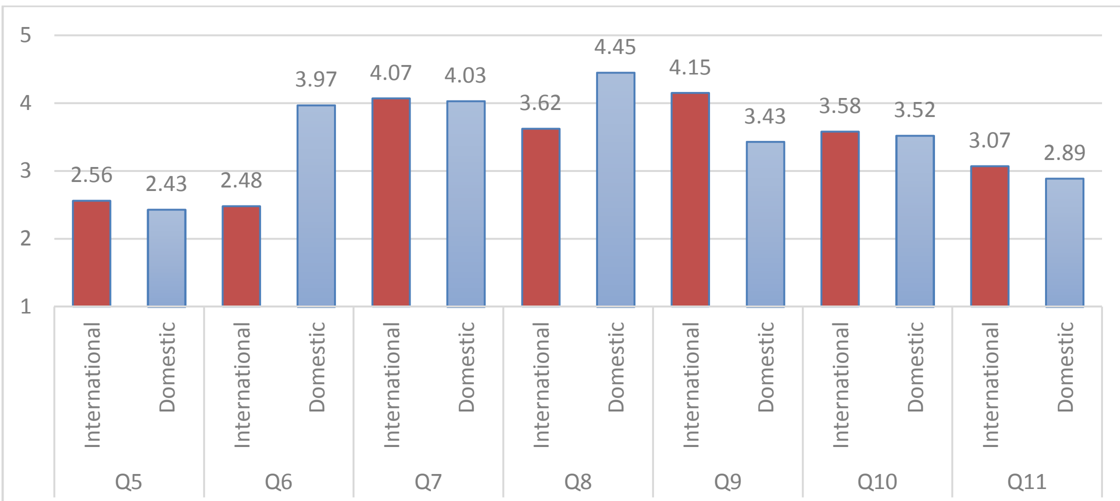


Figure 24. The mean of advisory 2 protective action selection by student type

Also, Table 26 shows participants' protective action selection under advisory 3 are significantly different across student type (*Wilks' Lambda* = .32; $F_{(6, 284)}$ = 99.74, p<.01); the interaction effect of the two factors are significant in this model (*Wilks' Lambda* = .72; $F_{(6, 284)}$ = 18.42, p<.01). Figure 25 shows that international and domestic students take different protective actions against tornado watches or warnings. First, international students (2.50) are more likely to ignore it and continue what they were doing than domestic students (1.98). Second, domestic students (4.28) are more likely to protect or secure their private property than international students (4.04). Third, domestic students (4.53) are more likely to monitor TV or radio than international students (3.82). Fourth, domestic students (3.82) are more likely to stay home and move to an interior room in the home than international students (3.23). Fifth, international students (3.39) are more likely to leave home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family house than domestic students (2.95). Sixth, international students (3.40) are more likely to leave home and take shelter at a public tornado shelter than domestic students (2.35). Seventh, international students (2.42) are more likely to leave home with no destination in mind, to get out of the path of the tornado than domestic students (1.58).

Table 26. The mean of advisory 3 protective action selection by student type

Protective Action Selection	Student type	Mean	Std. Deviation	N
Advisory 3 Q5	International	2.50	1.44	107
	Domestic	1.98	1.10	184
	Total	2.17	1.26	291
Advisory 3 Q6	International	4.04	1.14	107
	Domestic	4.28	.97	184
	Total	4.19	1.04	291
Advisory 3 Q7	International	3.82	1.22	107
	Domestic	4.53	.86	184
	Total	4.27	1.06	291
Advisory 3 Q8	International	3.23	1.23	107
	Domestic	3.82	1.25	184
	Total	3.60	1.27	291
Advisory 3 Q9	International	3.39	1.38	107
	Domestic	2.95	1.44	184
	Total	3.11	1.43	291
Advisory 3 Q10	International	3.40	1.34	107
	Domestic	2.35	1.36	184

	Total	2.74	1.44	291
Advisory 3 Q11	International	2.42	1.45	107
	Domestic	1.58	1.06	184
	Total	1.89	1.28	291

Effect (advisory 3 protective action): *Wilks' Lambda* = .32; $F_{(6, 284)} = 99.74$, $p<.01$

Effect (advisory 3 protective action * student type): *Wilks' Lambda* = .72; $F_{(6, 284)} = 18.42$, $p<.01$

When a tornado watch/warning is issued, what is your response?

Q5 = Ignore/continue what I am doing, Q6 = Protect/secure private property Q7 = Monitor TV or radio, Q8 = Stay home and move to an interior room in the home, Q9 = Leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house, Q10 = Leave my home and take shelter at a public tornado shelter, Q11 = Leave my home with no destination in mind, simply to get out of the path of the tornado

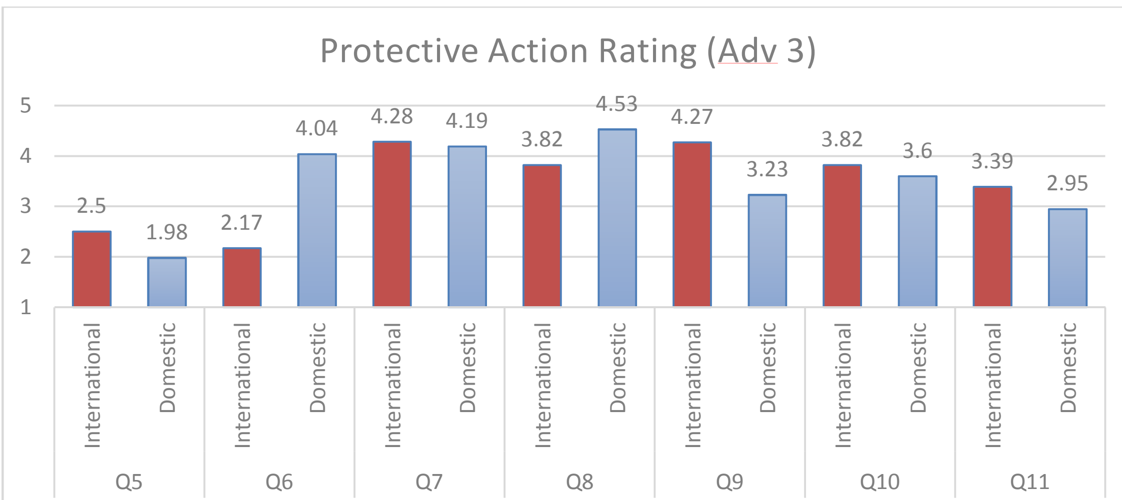


Figure 25. The mean of advisory 3 protective action selection by student type

Also, Table 27 shows participants' protective action selection under advisory 4 are significantly different across student type (*Wilks' Lambda* = .28; $F_{(6, 284)} = 122.60$, $p<.01$); the interaction effect of the two factors are significant in this model (*Wilks' Lambda* = .77; $F_{(6, 284)} = 14.31$, $p<.01$). Figure 26 shows that international and domestic students take different protective actions against tornado watches or warnings. First, international students (2.12) are more likely to ignore it and continue what they were doing than domestic students (1.64). Second, domestic students (4.47) are more likely to protect or secure their private property than international students (4.17). Third, domestic students (4.62) are more likely to monitor TV or radio than international students (3.99). Fourth, domestic students (3.92) are more likely to stay home and move to an interior room in the home than international students (3.57). Fifth, international students (3.56) are more likely to leave home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family house than domestic students (3.20). Sixth, international students (3.64) are more likely to leave home and take shelter at a public tornado shelter than domestic students (2.53). Seventh, international students (2.34) are more likely to leave home with no destination in mind, to get out of the path of the tornado than domestic students (1.57).

Table 27. The mean of advisory 4 protective action selection by student type

Protective Action Selection	Student type	Mean	Std. Deviation	N
Advisory 4 Q5	International	2.12	1.40	108
	Domestic	1.64	1.05	183
	Total	1.82	1.21	291
Advisory 4 Q6	International	4.17	1.18	108
	Domestic	4.47	.95	183
	Total	4.36	1.05	291
Advisory 4 Q7	International	3.99	1.23	108
	Domestic	4.62	.91	183
	Total	4.39	1.08	291
Advisory 4 Q8	International	3.57	1.46	108
	Domestic	3.92	1.32	183
	Total	3.79	1.38	291
Advisory 4 Q9	International	3.56	1.43	108
	Domestic	3.20	1.57	183
	Total	3.33	1.53	291

Advisory 4 Q10	International	3.64	1.46	108
	Domestic	2.53	1.53	183
	Total	2.94	1.60	291
Advisory 4 Q11	International	2.34	1.51	108
	Domestic	1.57	1.11	183
	Total	1.86	1.33	291

Effect (advisory 4 protective action): *Wilks' Lambda* = .28; $F_{(6, 284)}$ = 122.60, p <.01

Effect (advisory 4 protective action * student type): *Wilks' Lambda* = .77; $F_{(6, 284)}$ = 14.31, p <.01

When a tornado watch/warning is issued, what is your response?
Q5 = Ignore/continue what I am doing, Q6 = Protect/secure private property Q7 = Monitor TV or radio, Q8 = Stay home and move to an interior room in the home, Q9 = Leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house, Q10 = Leave my home and take shelter at a public tornado shelter, Q11 = Leave my home with no destination in mind, simply to get out of the path of the tornado

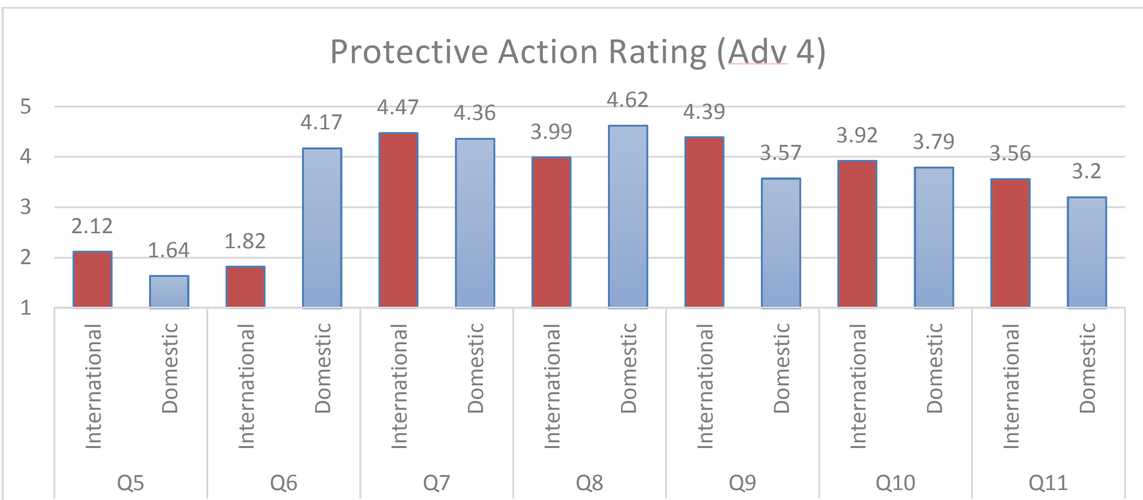


Figure 26. The mean of advisory 4 protective action selection by student type

Also, Table 28 shows participants' protective action selection under advisory 5 are significantly different across student type (*Wilks' Lambda* = .26; $F_{(6, 286)}$ = 138.51, p<.01); the interaction effect of the two factors are significant in this model (*Wilks' Lambda* = .78; $F_{(6, 286)}$ = 14.40, p<.01). Figure 27 shows that international and domestic students take different protective actions against tornado watches or warnings. First, international students (2.13) are more likely to ignore it and continue what they were doing than domestic students (1.42). Second, domestic students (4.55) are more likely to protect or secure their private property than international students (4.27). Third, domestic students (4.67) are more likely to monitor TV or radio than international students (4.26). Fourth, domestic students (4.05) are more likely to stay home and move to an interior room in the home than international students (3.85). Fifth, international students (3.62) are more likely to leave home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family house than domestic students (3.33). Sixth, international students (3.75) are more likely to leave home and take shelter at a public tornado shelter than domestic students (2.67). Seventh, international students (2.75) are more likely to leave home with no destination in mind, to get out of the path of the tornado than domestic students (1.67).

Table 28. The mean of advisory 5 protective action selection by student type

Protective Action Selection	Student type	Mean	Std. Deviation	N
Advisory 5 Q5	International	2.13	1.59	107
	Domestic	1.42	.87	186
	Total	1.68	1.23	293
Advisory 5 Q6	International	4.27	1.32	107
	Domestic	4.55	.97	186
	Total	4.45	1.12	293
Advisory 5 Q7	International	4.26	1.16	107
	Domestic	4.67	.85	186
	Total	4.52	1.00	293
Advisory 5 Q8	International	3.85	1.47	107
	Domestic	4.05	1.34	186
	Total	3.98	1.39	293
Advisory 5 Q9	International	3.62	1.53	107
	Domestic	3.33	1.65	186
	Total	3.43	1.61	293

Advisory 5 Q10	International	3.75	1.49	107
	Domestic	2.67	1.62	186
	Total	3.06	1.65	293
Advisory 5 Q11	International	2.75	1.75	107
	Domestic	1.67	1.25	186
	Total	2.06	1.54	293

Effect (advisory 5 protective action): *Wilks' Lambda* = .26; $F_{(6, 286)}$ = 138.51, p <.01

Effect (advisory 5 protective action * student type): *Wilks' Lambda* = .78; $F_{(6, 286)}$ = 14.40, p <.01

When a tornado watch/warning is issued, what is your response?
Q5 = Ignore/continue what I am doing, Q6 = Protect/secure private property Q7 = Monitor TV or radio, Q8 = Stay home and move to an interior room in the home, Q9 = Leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house, Q10 = Leave my home and take shelter at a public tornado shelter, Q11 = Leave my home with no destination in mind, simply to get out of the path of the tornado

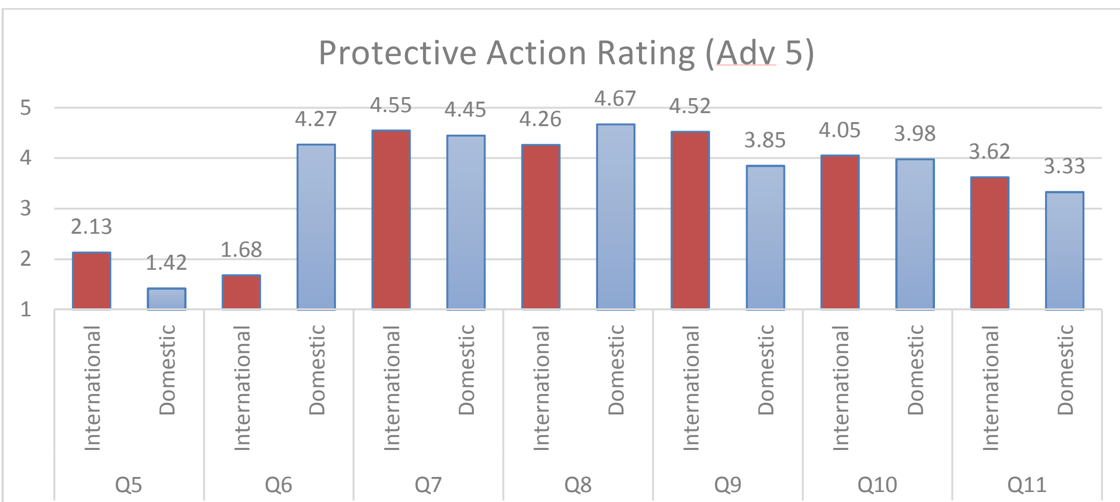


Figure 27. The mean of advisory 5 protective action selection by student type

Also, Table 29 shows participants' protective action selection under advisory 1 are significantly different across alert groups (*Wilks' Lambda* = .23; $F_{(6, 284)}$ = 154.66, p<.01); however, the interaction effect of the two factors are not significant in this model (*Wilks' Lambda* = .98; $F_{(6, 284)}$ = 1.04, *ns*). The table under advisory 1 shows that watch and warning group take different protective actions against tornado watches or warnings.

First, the warning group (2.71) is more likely to ignore it and continue what they were doing than the watch group (2.52). Second, the watch group (4.08) is more likely to protect or secure their private property than the warning group (4.07). Third, the watch group (4.17) is more likely to monitor TV or radio than the warning group (4.04). Fourth, the watch group (3.34) is more likely to stay home and move to an interior room in the home than the warning group (3.20). Fifth, the warning group (2.89) is more likely to leave home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family house than the watch group (2.71). Sixth, the warning group (3.34) and watch group (3.34) had no difference when they left home and took shelter at a public tornado shelter. Seventh, the warning group (1.63) is more likely to leave home with no destination in mind, to get out of the path of the tornado than the watch group (1.55).

Table 29. The mean of advisory 1 protective action selection by alert type

Protective Action Selection	alert type	Mean	Std. Deviation	N
Advisory 1 Q5	Watch	2.52	1.21	157
	Warning	2.71	1.27	134
	Total	2.61	1.24	291
Advisory 1 Q6	Watch	4.08	1.11	157
	Warning	4.06	1.14	134
	Total	4.07	1.12	291
Advisory 1 Q7	Watch	4.17	1.03	157
	Warning	4.04	1.14	134
	Total	4.11	1.08	291
Advisory 1 Q8	Watch	3.34	1.19	157
	Warning	3.20	1.19	134
	Total	3.27	1.19	291
Advisory 1 Q9	Watch	2.71	1.37	157
	Warning	2.89	1.42	134
	Total	2.79	1.40	291
Advisory 1 Q10	Watch	2.34	1.30	157

	Warning	2.34	1.42	134
	Total	2.34	1.36	291
Advisory 1 Q11	Watch	1.55	1.00	157
	Warning	1.63	1.03	134
	Total	1.59	1.01	291

Effect (advisory 5 protective action): *Wilks' Lambda* = .23; $F_{(6, 284)}$ = 154.66, p<.01
Effect (advisory 5 protective action * alert type): *Wilks' Lambda* = .98; $F_{(6, 284)}$ = 1.04, *ns*

When a tornado watch/warning is issued, what is your response?
Q5 = Ignore/continue what I am doing, Q6 = Protect/secure private property Q7 = Monitor TV or radio, Q8 = Stay home and move to an interior room in the home, Q9 = Leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house, Q10 = Leave my home and take shelter at a public tornado shelter, Q11 = Leave my home with no destination in mind, simply to get out of the path of the tornado

Also, Table 30 shows participants' protective action selection under advisory 2 are significantly different across alert groups (*Wilks' Lambda* = .29; $F_{(6, 281)}$ = 116.89, p<.01); however, the interaction effect of the two factors are not significant in this model (*Wilks' Lambda* = .97; $F_{(6, 281)}$ = 1.24, *ns*). The table under advisory 2 shows that watch and warning group take different protective actions against tornado watches or warnings. First, the warning group (2.56) is more likely to ignore it and continue what they were doing than the watch group (2.41). Second, the warning group (4.10) is more likely to protect or secure their private property than the watch group (3.97). Third, the warning group (4.16) is more likely to monitor TV or radio than the watch group (4.14). Fourth, the watch group (3.63) is more likely to stay home and move to an interior room in the home than the warning group (3.41). Fifth, the warning group (3.07) is more likely to leave home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family house than the watch group (2.86). Sixth, the warning group (2.61) is more likely to leave home and take shelter at a public tornado shelter than the watch group (2.51). Seventh, the warning group (1.71) is more likely to leave home with no destination in mind, to get out of the path of the tornado than the watch group (1.68).

Table 30. The mean of advisory 2 protective action selection by alert type

Protective Action Selection	alert type	Mean	Std. Deviation	N
Advisory 2 Q5	Watch	2.41	1.23	155
	Warning	2.56	1.27	133
	Total	2.48	1.25	288
Advisory 2 Q6	Watch	3.97	1.11	155
	Warning	4.10	1.04	133
	Total	4.03	1.08	288
Advisory 2 Q7	Watch	4.14	1.08	155
	Warning	4.16	1.08	133
	Total	4.15	1.08	288
Advisory 2 Q8	Watch	3.63	1.21	155
	Warning	3.41	1.24	133
	Total	3.52	1.22	288
Advisory 2 Q9	Watch	2.86	1.37	155
	Warning	3.07	1.39	133
	Total	2.95	1.38	288
Advisory 2 Q10	Watch	2.51	1.36	155
	Warning	2.61	1.38	133
	Total	2.56	1.37	288
Advisory 2 Q11	Watch	1.68	1.12	155
	Warning	1.71	1.07	133
	Total	1.69	1.09	288

Effect (advisory 2 protective action): *Wilks' Lambda* = .29; $F_{(6, 281)}$ = 116.89, p<.01
Effect (advisory 2 protective action * alert type): *Wilks' Lambda* = .97; $F_{(6, 281)}$ = 1.24, *ns*

When a tornado watch/warning is issued, what is your response?
Q5 = Ignore/continue what I am doing, Q6 = Protect/secure private property Q7 = Monitor TV or radio, Q8 = Stay home and move to an interior room in the home, Q9 = Leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house, Q10 = Leave my home and take shelter at a public tornado shelter, Q11 = Leave my home with no destination in mind, simply to get out of the path of the tornado

Also, Table 31 shows participants' protective action selection under advisory 3 are significantly different across alert groups (*Wilks' Lambda* = .31; $F_{(6, 284)}$ = 107.52, p<.01); however, the interaction effect of the two factors are not significant in this model (*Wilks' Lambda* = .99; $F_{(6, 284)}$ = .62, *ns*). The table under advisory 3 shows that the watch and warning groups take different protective actions against tornado watches or warnings. First, the watch group (2.22) is more likely to ignore it and continue what they were doing than the warning group (2.12). Second, the warning group (4.29) is more likely to protect or secure their private property than the watch group (4.10). Third, the warning group (4.33) is more likely to monitor TV or radio than the watch group (4.22). Fourth, the warning group (3.62) is more likely to stay home and move to an interior room in the home than the watch group (3.59). Fifth, the warning group (3.18) is more likely to leave home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family house than the watch group (3.05). Sixth, the warning group (2.75) is more likely to leave home and take shelter at a public tornado shelter than the watch group (2.72). Seventh, the watch group (1.96) is more likely to leave home with no destination in mind, to get out of the path of the tornado than the warning group (1.80).

Table 31. The mean of advisory 3 protective action selection by alert type

Protective Action Selection	alert type	Mean	Std. Deviation	N
Advisory 3 Q5	Watch	2.22	1.22	153
	Warning	2.12	1.30	138
	Total	2.17	1.26	291
Advisory 3 Q6	Watch	4.10	1.04	153
	Warning	4.29	1.04	138
	Total	4.19	1.04	291
Advisory 3 Q7	Watch	4.22	1.09	153
	Warning	4.33	1.04	138
	Total	4.27	1.06	291

Advisory 3 Q8	Watch	3.59	1.24	153
	Warning	3.62	1.30	138
	Total	3.60	1.27	291
Advisory 3 Q9	Watch	3.05	1.34	153
	Warning	3.18	1.53	138
	Total	3.11	1.43	291
Advisory 3 Q10	Watch	2.72	1.39	153
	Warning	2.75	1.50	138
	Total	2.74	1.44	291
Advisory 3 Q11	Watch	1.96	1.34	153
	Warning	1.80	1.21	138
	Total	1.89	1.28	291

Effect (advisory 3 protective action): *Wilks' Lambda* = .31; $F_{(6, 284)}$ = 107.52, $p<.01$

Effect (advisory 3 protective action * alert type): *Wilks' Lambda* = .98; $F_{(6, 284)}$ = .62, *ns*

When a tornado watch/warning is issued, what is your response?
Q5 = Ignore/continue what I am doing, Q6 = Protect/secure private property Q7 = Monitor TV or radio, Q8 = Stay home and move to an interior room in the home, Q9 = Leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house, Q10 = Leave my home and take shelter at a public tornado shelter, Q11 = Leave my home with no destination in mind, simply to get out of the path of the tornado

Also, Table 32 shows participants' protective action selection under advisory 4 are significantly different across alert groups (*Wilks' Lambda* = .27; $F_{(6, 284)}$ = 130.72, $p<.01$); however, the interaction effect of the two factors are not significant in this model (*Wilks' Lambda* = .99; $F_{(6, 284)}$ = .45, *ns*). The table under advisory 4 shows that the watch and warning groups take different protective actions against tornado watches or warnings. First, the watch group (1.86) is more likely to ignore it and continue what they were doing than the warning group (1.78). Second, the warning group (4.43) is more likely to protect or secure their private property than the watch group (4.30). Third, the warning group (4.39) and the watch group (4.39) had no difference when they monitored TV or radio. Fourth, the watch group (3.81) is more likely to stay home and move to an interior room in the home than the warning group (3.78). Fifth, the watch group (3.34) is more likely to leave home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family house than the warning group (3.32). Sixth, the warning group (2.96) is more likely to leave home and take shelter at a public tornado shelter than the watch group (2.92). Seventh, the watch group (1.90) is more likely to leave home with no destination in mind, to get out of the path of the tornado than the warning group (1.82).

Table 32. The mean of advisory 4 protective action selection by alert type

Protective Action Selection	alert type	Mean	Std. Deviation	N
Advisory 4 Q5	Watch	1.86	1.22	155
	Warning	1.78	1.21	136
	Total	1.82	1.21	291
Advisory 4 Q6	Watch	4.30	1.06	155
	Warning	4.43	1.04	136
	Total	4.36	1.05	291
Advisory 4 Q7	Watch	4.39	1.05	155
	Warning	4.39	1.12	136
	Total	4.39	1.08	291
Advisory 4 Q8	Watch	3.81	1.36	155
	Warning	3.78	1.41	136
	Total	3.79	1.38	291
Advisory 4 Q9	Watch	3.34	1.47	155
	Warning	3.32	1.61	136
	Total	3.33	1.53	291
Advisory 4 Q10	Watch	2.92	1.54	155
	Warning	2.96	1.66	136
	Total	2.94	1.60	291
Advisory 4 Q11	Watch	1.90	1.33	155
	Warning	1.82	1.33	136
	Total	1.86	1.33	291

Effect (advisory 4 protective action): *Wilks' Lambda* = .27; $F_{(6, 284)}$ = 130.72, *p* <.01
Effect (advisory 4 protective action * alert type): *Wilks' Lambda* = .99; $F_{(6, 284)}$ = .45, *ns*

When a tornado watch/warning is issued, what is your response?
Q5 = Ignore/continue what I am doing, Q6 = Protect/secure private property Q7 = Monitor TV or radio, Q8 = Stay home and move to an interior room in the home, Q9 = Leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house, Q10 = Leave my home and take shelter at a public tornado shelter, Q11 = Leave my home with no destination in mind, simply to get out of the path of the tornado

Also, Table 33 shows participants' protective action selection under advisory 5 are significantly different across alert groups (*Wilks' Lambda* = .25; $F_{(6, 286)}$ = 146.17, *p*<.01); however, the interaction effect of the two factors are not significant in this model (*Wilks' Lambda* = .99; $F_{(6, 286)}$ = .68, *ns*). The table under advisory 5 shows that the watch and warning groups take different protective actions against tornado watches or warnings. First, the watch group (1.70) is more likely to ignore it and continue what they were doing than the warning group (1.66). Second, the warning group (4.46) is more likely to protect or secure their private property than the watch group (4.44). Third, the warning group (4.57) is more likely to monitor TV or radio than the watch group (4.48). Fourth, the watch group (4.03) is more likely to stay home and move to an interior room in the home than the warning group (3.92). Fifth, the watch group (3.50) is more likely to leave home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family house than the warning group (3.36). Sixth, the watch group (3.14) is more likely to leave home and take shelter at a public tornado shelter than the warning group (2.97). Seventh, the warning group (2.07) is more likely to leave home with no destination in mind, to get out of the path of the tornado than the watch group (2.06).

Table 33. The mean of advisory 5 protective action selection by alert type

Protective Action Selection	alert type	Mean	Std. Deviation	N
Advisory 5 Q5	Watch	1.70	1.22	155
	Warning	1.66	1.25	138
	Total	1.68	1.23	293
Advisory 5 Q6	Watch	4.44	1.11	155
	Warning	4.46	1.13	138
	Total	4.45	1.12	293
Advisory 5 Q7	Watch	4.48	1.05	155
	Warning	4.57	.93	138
	Total	4.52	1.00	293
Advisory 5 Q8	Watch	4.03	1.38	155
	Warning	3.92	1.39	138
	Total	3.98	1.39	293
Advisory 5 Q9	Watch	3.50	1.57	155
	Warning	3.36	1.65	138
	Total	3.43	1.61	293
Advisory 5 Q10	Watch	3.14	1.63	155
	Warning	2.97	1.67	138
	Total	3.06	1.65	293
Advisory 5 Q11	Watch	2.06	1.53	155
	Warning	2.07	1.55	138
	Total	2.06	1.54	293

Effect (advisory 5 protective action): *Wilks' Lambda* = .25; $F_{(6, 286)}$ = 146.17, p <.01
Effect (advisory 5 protective action * alert type): *Wilks' Lambda* = .99; $F_{(6, 286)}$ = .68, *ns*

When a tornado watch/warning is issued, what is your response?
Q5 = Ignore/continue what I am doing, Q6 = Protect/secure private property Q7 = Monitor TV or radio, Q8 = Stay home and move to an interior room in the home, Q9 = Leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house, Q10 = Leave my home and take shelter at a public tornado shelter, Q11 = Leave my home with no destination in mind, simply to get out of the path of the tornado

Correlation analysis was used to answer PARQ11 (*What are the correlation among protective action and demographic variables?*); the results are presented in the table 34. *Age* did not correlate with *protective action - ignore/continue what I am doing* *when a tornado watch/warning is issued(Q5)* (*r* = .07, *ns*). *Family income* is negatively correlated with *protective action* Q5 (*r* = -.13, *p* < .05). This finding indicates when family income is low, the participants are more likely to ignore the warning or watch messages.

Table 34. Correlations among protective action Q5, age, and family income

Variables	1	2	3
1.Protective action Q5	-		
2.Age	.07	-	
3.Family income	-.13*	-.31**	-

**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed)
Q5 = Ignore/continue what I am doing when a tornado watch / warning is issued

Table 35 shows that *Age* did not correlate with *protective action* - *Protect/secure the private property when a tornado watch/warning is issued(*Q6) (*r* = -.57, *ns*). *Family income* did not correlate with *protective action* Q6 (*r* = -.09, *ns*).

Table 35. Correlations among protective action Q6, age, and family income

Variables	1	2	3
1.Protective action Q6	-		
2.Age	-.57	-	
3.Family income	.09	-.31**	-

**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed)
Q6 = Protect/secure private property when a tornado watch / warning is issued

Table 36 shows that *age* did not correlate with *protective action* - *Monitor TV or radio when a tornado watch/warning is issued*(Q7) (*r* = -.04, *ns*). *Family income* was positively correlated with *protective action* Q7 (*r* = .13, *p* <.05). This finding indicates when family income is high, the participants are more likely to monitor TV or radio when a tornado watch/warning is issued.

Table 36. Correlations among protective action Q7, age, and family income

Variables	1	2	3
1.Protective action Q7	-		
2.Age	-.04	-	
3.Family income	.13*	-.31**	-

**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed)
Q7 = Monitor TV or radio when a tornado watch/warning is issued

Table 37 shows that *age* was negatively correlated with *protective action* - *Stay home and move to an interior room in the home when a tornado watch/warning is issued* (Q8) (r = -.14, p <.05). This finding indicates younger participants are more likely to stay home and move to an interior room in the home when a tornado watch/warning is issued. *Family income* was positively correlated with *protective action* Q8 (r = .13, p <.05). This finding indicates when family income is high, the participants are more likely to stay home and move to an interior room in the home when a tornado watch/warning is issued.

Table 37. Correlations among protective action Q8, age, and family income

Variables	1	2	3
1.Protective action Q8	-		
2.Age	-.14*	-	
3.Family income	.13*	-.31**	-

**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed)
Q8 = Stay home and move to an interior room in the home when a tornado watch/warning is issued

Table 38 shows that *age* was not correlated with *protective action* - Leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house when a tornado watch/warning is issued(Q9) (r = .07, *ns*). *Family income* was negatively correlated with *protective action* Q9 (r = -.12, p <.05). This finding indicates when family income is low, the participants are more likely to leave their home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house when a tornado watch/warning is issued.

Table 38. Correlations among protective action Q9, age, and family income

Variables	1	2	3
1.Protective action Q9	-		
2.Age	.07	-	
3.Family income	-.12*	-.31**	-

**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed)
Q9 = Leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house when a tornado watch/warning is issued

Table 39 shows that *age* was positively correlated with *protective action - Leave my home and take shelter at a public tornado shelter when a tornado watch/warning is issued* (Q10) (r = .25, p <.01). This finding indicates younger participants are less likely to leave my home and take shelter at a public tornado shelter when a tornado watch/warning is issued. *Family income* was negatively correlated with *protective action* Q10 (r = -.24, p <.01). This finding indicates when family income is low, the participants are more likely to leave their home and take shelter at a public tornado shelter when a tornado watch/warning is issued.

Table 39. Correlations among protective action Q10, age, and family income

Variables	1	2	3
1.Protective action Q10	-		
2.Age	.25**	-	
3.Family income	-.24**	-.31**	-

**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed)
Q10 = Leave my home and take shelter at a public tornado shelter when a tornado watch / warning is issued

Table 40 shows that *age* was not correlated with *protective action - Leave my home with no destination in mind, to get out of the path of the tornado when a tornado watch/warning is issued*(Q11) (*r* = .02, *ns*). *Family income* was not correlated with *protective action* Q11 (*r* = -.10, *ns*).

Table 40. Correlations among protective action Q11, age, and family income

Variables	1	2	3
1.Protective action Q11	-		
2.Age	.02	-	
3.Family income	-.10	-.31**	-

**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed)
Q11 = Leave my home with no destination in mind, simply to get out of the path of the tornado when a tornado watch / warning is issued

4.6. Tornado and life experience RQs

Correlation analysis was used to answer TELERQ1 (*What are the correlation among tornado experience, risk perception, and protective action under advisory 1?*); the results are presented in Table 41.

Direct experience: the *direct experience* was negatively correlated with *advisory 1 risk perception* (*r* = -.14, *p <.05*), *advisory 1 protective action - leave my home and take shelter at a public tornado shelter* (Q10) (*r* = -.18, *p <.01*) and *protective action - leave my home with no destination in mind, simply to get out of the path of the tornado* (Q11) (*r* = -.20, *p <.01*) This finding indicates when the direct experience is low, the participants are more likely to have risk perception, to leave their home and take shelter at a public tornado shelter and leave their home with no destination in mind, to get out of the path of the tornado. The *direct experience* was positively correlated with *Advisory 1 protective action* - *monitor TV or radio* (Q7) ($r = .26$, $p < .01$). This finding indicates when the direct experience is high, the participants are more likely to monitor TV or radio.

Indirect experience: the *indirect experience* was negatively correlated with *Advisory 1 protective action* - *leave my home and take shelter at a public tornado shelter* (Q10) ($r = -.19$, $p < .01$). This finding indicates when the indirect experience is low, the participants are more likely to leave their home and take shelter at a public tornado shelter. The *indirect experience* was positively correlated with *Advisory 1 protective action* - *ignore/continue what I am doing* (Q5) ($r = .14$, $p < .05$) and *protective action* - *monitor TV or radio* (Q7) ($r = .19$, $p < .01$). This finding indicates when the indirect experience is high, the participants are more likely to ignore watch or warning message/continue what they are doing and monitor TV or radio.

Vicarious experience: the *vicarious experience* was negatively correlated with *advisory 1 protective action* - *leave my home and take shelter at a public tornado shelter* (Q10) ($r = -.10$, $p < .01$) and *protective action* - *leave my home with no destination in mind, simply to get out of the path of the tornado* (Q11) ($r = -.23$, $p < .01$). This finding indicates when *vicarious* experience is low, the participants are more likely to leave their home and take shelter at a public tornado shelter and leave their home with no destination in mind, to get out of the path of the tornado. The *vicarious experience* was positively correlated with *Advisory 1 protective action* - *protect/secure private property* (Q6) ($r = .15$, $p < .01$) *and protective action* - *monitor TV or radio* (Q7) ($r = .30$, $p < .05$). This finding indicates when *vicarious* experience is high, the participants are more likely to protect/secure private property and monitor TV or radio.

Risk perception: *advisory 1 risk perception was* negatively correlated with *Advisory 1 protective action* - *ignore/continue what I am doing* (Q5) ($r = -.23$, $p < .01$). This finding indicates when *risk perception* is low, the participants are more likely to ignore watch or warning message/continue what they are doing. *Advisory 1 risk perception was* positively correlated with *Advisory 1 protective action* - *protect/secure private property* (Q6) ($r = .25$, $p < .01$), *protective action* - monitor TV or radio (Q7) ($r = .14$, $p < .01$), *protective action* - *stay home and move to an interior room in the home* (Q8) ($r = .23$, $p < .01$), *protective action* - *leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house* (Q9) ($r = .33$, $p < .01$), *protective action* - *leave my home and take shelter at a public tornado shelter* (Q10) ($r = .37$, $p < .01$) and *protective action* - leave my home with no destination in mind, simply to get out of the path of the tornado (Q11) ($r = .18$, $p < .01$). This finding indicates when *risk perception* is high, the participants are more likely to protect/secure private property, monitor TV or radio, stay home and move to an interior room in the home, leave their home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house, leave their home and take shelter at a public tornado shelter and leave their home with no destination in mind, simply to get out of the path of the tornado.

Table 41. Correlations among experience, Advisory 1 risk perception, and Advisory 1 protective action

Variables	1	2	3	4	5	6	7	8	9	10	11	12
1. Direct experience	-											
2. Indirect experience	.64**	-										
3. Vicarious experience	.50**	.49**	-									
4. Life experience	.27**	.35**	.29**	-								
5. Adv1 risk perception	-.14*	-.08	-.06	.05	-							
6. Adv1 protective action Q5	.04	.14*	-.07	.06	-.23**	-						
7. Adv1 protective action Q6	.02	-.04	.15**	.09	.25**	-.27**	-					
8. Adv1 protective action Q7	.26**	.19**	.30**	.09	.14**	-.26**	.38**	-				
9. Adv1 protective action Q8	-.03	-.06	-.00	-.03	.23**	-.24**	.34**	.34**	-			
10. Adv1 protective action Q9	-.05	-.03	-.10	-.08	.33**	-.32**	.25**	.26**	.24**	-		
11. Adv1 protective action Q10	-.18**	-.19**	-.10**	-.10	.37**	-.31**	.21**	.04**	.12*	.57**	-	
12. Adv1 protective action Q11	-.20**	-.08	-.23**	-.11	.18**	.09	.03**	-.11	.12*	.26**	.42**	-

**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed)
Q5 = Ignore/continue what I am doing, Q6 = Protect / secure private property Q7 = Monitor TV or radio, Q8 = Stay home and move to an interior room in the home, Q9 = Leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house, Q10 = Leave my home and take shelter at a public tornado shelter, Q11 = Leave my home with no destination in mind, simply to get out of the path of the tornado

Correlation analysis was used to answer TELERQ2 (*What are the correlation among tornado experience, risk perception, and protective action under advisory 2?*); the results are presented in Table 42.

Direct experience: the *direct experience* was negatively correlated with *advisory 2 protective action - leave my home and take shelter at a public tornado shelter* (Q10) (r = -.15, p <*.05*) and *protective action - leave my home with no destination in mind, to get out of the path of the tornado* (Q11) (r = -.16, p <*.01*). This finding indicates when the *direct experience* is low, the participants are more likely to leave their home and take shelter at a public tornado shelter and leave their home with no destination in mind, to get out of the path of the tornado. The *direct experience* was positively correlated with *advisory 2 protective action - monitor TV or radio* (Q7) (r = .24, p <*.01*). This finding indicates when the *direct experience* is high, the participants are more likely to monitor TV or radio.

Indirect experience: The *indirect experience* was negatively correlated with *Advisory 2 protective action - leave my home and take shelter at a public tornado shelter* (Q10) (r = -.20, p <*.01*). This finding indicates when the *indirect experience* is low, the participants are more likely to leave their home and take shelter at a public tornado shelter. The *indirect experience* was positively correlated with *Advisory 2 protective action - monitor TV or radio* (Q7) (r = .15, p <*.01*). This finding indicates when the *indirect experience* is high, the participants are more likely to monitor TV or radio.

Vicarious experience: the *vicarious experience* was negatively correlated with *advisory 2 protective action - leave my home and take shelter at a public tornado shelter* (Q10) (r

= -.23, *p <.01*) and *protective action - leave my home with no destination in mind, simply to get out of the path of the tornado* (Q11) (*r* = -.19, *p <.01*). This finding indicates when the *vicarious experience* is low, the participants are more likely to leave their home and take shelter at a public tornado shelter and leave their home with no destination in mind, to get out of the path of the tornado. The *vicarious experience* was positively correlated with *advisory 2 protective action - monitor TV or radio* (Q7) (*r* = .31, *p <.01*). This finding indicates when the *vicarious experience* is high, the participants are more likely to monitor TV or radio.

Risk perception: *advisory 2 risk perception was* negatively correlated with *Advisory 2 protective action - ignore/continue what I am doing* (Q5) (*r* = -.31, *p <.01*). This finding indicates when *risk perception* is low, the participants are more likely to ignore watch or warning message/continue what they are doing. *Advisory 2 risk perception was* positively correlated with *advisory 2 protective action - protect/secure private property* (Q6) (*r* = .36, *p <.01*), *protective action - monitor TV or radio* (Q7) (*r* = .14, *p <.05*), *protective action - stay home and move to an interior room in the home* (Q8) (*r* = .26, *p <.01*), *protective action - leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house* (Q9) (*r* = .32, *p <.01*) and *protective action - leave my home and take shelter at a public tornado shelter* (Q10) (*r* = .34, *p <.01*). This finding indicates when *risk perception* is high, the participants are more likely to protect/secure private property, monitor TV or radio, stay home and move to an interior room in the home, leave their home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house and leave their home and take shelter at a public tornado shelter.

Table 42. Correlations among experience, Advisory 2 risk perception, and Advisory 2 protective action

Variables	1	2	3	4	5	6	7	8	9	10	11	12
1. Direct experience	-											
2. Indirect experience	.64**	-										
3. Vicarious experience	.50**	.49**	-									
4. Life experience	.27**	.35**	.29**	-								
5. Adv2 risk perception	-.09	-.08	-.01	-.03	-							
6. Adv2 protective action Q5	.04	.10	-.10	-.00	-.31**	-						
7. Adv2 protective action Q6	.01	-.09	.08	.00	.36**	-.27**	-					
8. Adv2 protective action Q7	.24**	.15**	.31**	.08	.14*	-.21**	.43**	-				
9. Adv2 protective action Q8	.01	-.02	.01	.04	.26**	-.26**	.35**	.24**	-			
10. Adv2 protective action Q9	-.06	-.09	-.10	-.06	.32**	-.24**	.28**	.19**	.26**	-		
11. Adv2 protective action Q10	-.15*	-.20**	-.23**	-.10	.34**	-.22**	.14*	-.04	.15**	.61**	-	
12. Adv2 protective action Q11	-.16**	-.11	-.19**	-.09	.10	.11	-.07	-.22**	.04	.16**	.38**	-

**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed)
Q5 = Ignore/continue what I am doing, Q6 = Protect / secure private property Q7 = Monitor TV or radio, Q8 = Stay home and move to an interior room in the home, Q9 = Leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house, Q10 = Leave my home and take shelter at a public tornado shelter, Q11 = Leave my home with no destination in mind, simply to get out of the path of the tornado

Correlation analysis was used to answer TELERQ3 (*What are the correlation among tornado experience, risk perception, and protective action under advisory 3?*); the results are presented in Table 43.

Direct experience: the *direct experience* was negatively correlated with *advisory 3 risk perception* ($r = -.16$, $p < .01$) and *advisory 3 protective action - leave my home with no destination in mind, to get out of the path of the tornado* (Q11) ($r = -.16$, $p < .01$). This finding indicates when the *direct experience* is low, the participants are more likely to have higher *risk perception* and leave their home with no destination in mind, to get out of the path of the tornado.

Indirect experience: the *indirect experience* was negatively correlated with *advisory 3 risk perception* ($r = -.16$, $p < .01$), *advisory 3 protective action - leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house* (Q9) ($r = -.13$, $p < .05$) and *protective action - leave my home and take shelter at a public tornado shelter* (Q10) ($r = -.18$, $p < .01$). This finding indicates when the *indirect experience* is low, the participants are more likely to have *risk perception,* leave their home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house and leave their home and take shelter at a public tornado shelter. The *indirect experience* was positively correlated with *Advisory 3 protective action - monitor TV or radio* (Q7) ($r = .13$, $p < .05$). This finding indicates when the *indirect experience* is high, the participants are more likely to monitor TV or radio.

Vicarious experience: the *vicarious experience* was negatively correlated with *advisory 3 protective action - ignore/continue what I am doing* (Q5) ($r = -.16$, $p < .01$), *advisory 3* *protective action - leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house* (Q9) ($r = -.12$, $p < .05$), *protective action - leave my home and take shelter at a public tornado shelter* (Q10) ($r = -.24$, $p < .01$) and *protective action - leave my home with no destination in mind, to get out of the path of the tornado* (Q11) ($r = -.16$, $p < .01$). This finding indicates when the *vicarious experience* is low, the participants are more likely to ignore watch or warning message/continue what they are doing, leave their home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house, leave their home and take shelter at a public tornado shelter, and leave their home with no destination in mind, to get out of the path of the tornado. The *vicarious experience* was positively correlated with *Advisory 3 protective action - protect/secure private property* (Q6) ($r = .18$, $p < .01$) and *protective action - monitor TV or radio* (Q7) ($r = .32$, $p < .01$). This finding indicates when the *vicarious experience* is high, the participants are more likely to protect/secure private property and monitor TV or radio.

Risk perception: *advisory 3 risk perception was* negatively correlated with *Advisory 3 protective action - ignore/continue what I am doing* (Q5) ($r = -.34$, $p < .01$). This finding indicates when *risk perception* is low, the participants are more likely to ignore watch or warning message/continue what they are doing. *Advisory 3 risk perception was* positively correlated with *advisory 3 protective action - protect/secure private property* (Q6) ($r = .37$, $p < .01$), *protective action - monitor TV or radio* (Q7) ($r = 22$, $p < .01$), *protective action - stay home and move to an interior room in the home* (Q8) ($r = .26$, $p < .01$), *protective action* - leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house (Q9) ($r = .33$, $p < .01$), *protective action* - *leave my home and take shelter at a public tornado shelter* (Q10) (*r* = .32, $p < .01$) and *protective action* - *leave my home with no destination in mind, to get out of the path of the tornado* (Q11) (*r* = .18, $p < .01$). This finding indicates when *risk perception* is high, the participants are more likely to protect/secure private property, stay home and move to an interior room in the home, leave their home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house, leave their home and take shelter at a public tornado shelter and leave their home with no destination in mind, to get out of the path of the tornado.

Table 43. Correlations among experience, Advisory 3 risk perception, and Advisory 3 protective action

Variables	1	2	3	4	5	6	7	8	9	10	11	12
1. Direct experience	-											
2. Indirect experience	.64**	-										
3. Vicarious experience	.50**	.49**	-									
4. Life experience	.27**	.35**	.29**	-								
5. Adv3 risk perception	-.16**	-.16**	-.01	-.03	-							
6. Adv3 protective action Q5	-.02	.05	-.16**	-.06	-.34**	-						
7. Adv3 protective action Q6	.04	-.02	.18**	.11	.37**	-.24**	-					
8. Adv3 protective action Q7	.23**	.13*	.32**	.05	.22**	-.19**	.63**	-				
9. Adv3 protective action Q8	.06	.04	.11	.02	.26**	-.25**	.38**	.39**	-			
10. Adv3 protective action Q9	-.08	-.13*	-.12*	-.04	.33**	-.14*	.22**	.14*	.18**	-		
11. Adv3 protective action Q10	-.09	-.18**	-.24**	-.09	.32**	-.06	.07	.05	.08	.66**	-	
12. Adv3 protective action Q11	-.17**	-.10	-.16**	-.07	.18**	.21**	-.05	-.14*	-.02	.19**	.37**	-

**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed)
Q5 = Ignore/continue what I am doing, Q6 = Protect / secure private property Q7 = Monitor TV or radio, Q8 = Stay home and move to an interior room in the home, Q9 = Leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house, Q10 = Leave my home and take shelter at a public tornado shelter, Q11 = Leave my home with no destination in mind, simply to get out of the path of the tornado

Correlation analysis was used to answer TELERQ4 (*What are the correlation among tornado experience, risk perception, and protective action under advisory 4?*); the results are presented in Table 44.

Direct experience: the *direct experience* was negatively correlated with *advisory 4 risk perception* (r = -.12, p <*.05*), and *advisory 4 protective action* - *leave my home with no destination in mind, to get out of the path of the tornado* (Q11) (r = -.15, p <*.05*). This finding indicates when the *direct experience* is low, the participants are more likely to have higher risk perception, and leave their home with no destination in mind, to get out of the path of the tornado. The *direct experience* was positively correlated with *Advisory 4 protective action* - *monitor TV or radio* (Q7) (r = .23, p <*.01*). This finding indicates when the *direct experience* is high, the participants are more likely to monitor TV or radio.

Indirect experience: the *indirect experience* was negatively correlated with *Advisory 4 protective action* - *leave my home and take shelter at a public tornado shelter* (Q10) (r = -.20, p <*.01*). This finding indicates when the *indirect experience* is low, the participants are more likely to leave their home and take shelter at a public tornado shelter. The *indirect experience* was positively correlated with *Advisory 4 protective action* - *monitor TV or radio* (Q7) (r = .15, p <*.05*). This finding indicates when the *indirect experience* is high, the participants are more likely to monitor TV or radio.

Vicarious experience: the *vicarious experience* was negatively correlated with *advisory 4 protective action* - *ignore/continue what I am doing* (Q5) (r = -.15, p <*.01*), *protective action* - *leave my home and take shelter at a public tornado shelter* (Q10) (r = -.18, p

$<.01$) and *protective action - leave my home with no destination in mind, to get out of the path of the tornado* (Q11) ($r = -.23$, $p < .01$). This finding indicates when the *vicarious experience* is low, the participants are more likely to ignore/continue what they are doing, leave their home and take shelter at a public tornado shelter and leave my home with no destination in mind, simply to get out of the path of the tornado. The *vicarious experience* was positively correlated with *advisory 4 protective action - protect/secure private property* (Q6) ($r = .17$, $p < .01$), *protective action - monitor TV or radio* (Q7) ($r = .28$, $p < .01$) and *protective action - stay home and move to an interior room in the home* (Q8) ($r = .12$, $p < .05$). This finding indicates when the *vicarious experience* is high, the participants are more likely to protect/secure private property, monitor TV or radio and *s*tay home and move to an interior room in the home.

Risk perception*: advisory 4 risk perception was* negatively correlated with *advisory 4 protective action - ignore/continue what I am doing* (Q5) ($r = -.32$, $p < .01$). This finding indicates when *risk perception* is low, the participants are more likely to ignore watch or warning message/continue what they are doing*. advisory 4 risk perception was* positively correlated with *advisory 4 protective action - protect/secure private property* (Q6) ($r = .43$, $p < .01$), *protective action - monitor TV or radio* (Q7) ($r = .32$, $p < .01$), *protective action - stay home and move to an interior room in the home* (Q8) ($r = .35$, $p < .01$), *protective action - leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house* (Q9) ($r = .26$, $p < .01$), *protective action - leave my home and take shelter at a public tornado shelter* (Q10) ($r = .28$, $p < .01$) and *protective action - leave my home with no destination in mind, simply to get out of the path of the tornado* (Q11) ($r = .12$, $p < .01$). This finding indicates when *risk perception* is high, the participants are more likely to protect/secure private property, monitor TV or radio, stay home and move to an interior room in the home, leave their home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house, leave their home and take shelter at a public tornado shelter, and leave their home with no destination in mind, to get out of the path of the tornado.

Table 44. Correlations among experience, Advisory4 risk perception, and Advisory 4 protective action

Variables	1	2	3	4	5	6	7	8	9	10	11	12
1. Direct experience	-											
2. Indirect experience	.64**	-										
3. Vicarious experience	.50**	.49**	-									
4. Life experience	.27**	.35**	.29**	-								
5. Adv4 risk perception	-.12*	-.10	.06	-.01	-							
6. Adv4 protective action Q5	-.02	.00	-.15**	-.06	-.32**	-						
7. Adv4 protective action Q6	.05	-.03	.17**	.10	.43**	-.25**	-					
8. Adv4 protective action Q7	.23**	.15*	.28**	.08	.32**	-.19**	.64**	-				
9. Adv4 protective action Q8	.06	.06	.12*	.04	.35**	-.17**	.36**	.45**	-			
10. Adv4 protective action Q9	-.05	-.10	-.11	-.00	.26**	-.08	.26**	.19**	.06	-		
11. Adv4 protective action Q10	-.10	-.20**	-.18**	-.07	.28**	.03	.13*	.03	.03	.71**	-	
12. Adv4 protective action Q11	-.15*	-.08	-.15**	-.04	.12**	.33**	-.05	-.11	.04	.26**	.43**	-

**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed)
Q5 = Ignore/continue what I am doing, Q6 = Protect / secure private property Q7 = Monitor TV or radio, Q8 = Stay home and move to an interior room in the home, Q9 = Leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house, Q10 = Leave my home and take shelter at a public tornado shelter, Q11 = Leave my home with no destination in mind, simply to get out of the path of the tornado

Correlation analysis was used to answer TELERQ5 (*What are the correlation among tornado experience, risk perception, and protective action under advisory 5?*); the results are presented in Table 45.

Direct experience: The *direct experience* was negatively correlated with *Advisory 5 protective action - leave their home with no destination in mind, to get out of the path of the tornado* (Q11) (r = -.17, p <*.01*). This finding indicates when the *direct experience* is low, the participants are more likely to leave their home with no destination in mind, to get out of the path of the tornado. The *direct experience* was positively correlated with *advisory 5 protective action - monitor TV or radio* (Q7) (r = .17, p <*.01*). This finding indicates when the *direct experience* is high, the participants are more likely to monitor TV or radio.

Indirect experience: The *indirect experience* was negatively correlated with *Advisory 5 protective action - leave my home and take shelter at a public tornado shelter* (Q10) (r = -.14, p <*.05*) and *protective action - leave my home with no destination in mind, to get out of the path of the tornado* (Q11) (r = -.13, p <*.05*). This finding indicates when the *indirect experience* is low, the participants are more likely to leave their home and take shelter at a public tornado shelter and leave their home with no destination in mind, to get out of the path of the tornado. The *indirect experience* was positively correlated with *advisory 5 protective action - monitor TV or radio* (Q7) (r = .19, p <*.01*) and *protective action - stay home and move to an interior room in the home* (Q8) (r = .15, p <*.05*). This finding indicates when the *indirect experience* is high, the participants are more likely to monitor TV or radio and stay home and move to an interior room in the home.

Vicarious experience: the *vicarious experience* was negatively correlated with *advisory 5 protective action* - ignore/continue what I am doing (Q5) (r = -.22, p <.01), *advisory 5 protective action* - leave my home and take shelter at a public tornado shelter (Q10) (r = -.19, p <.01) and *protective action - leave my home with no destination in mind, to get out of the path of the tornado* (Q11) (r = -.21, p <.01). This finding indicates when the *vicarious experience* is low, the participants are more likely to ignore/continue what they are doing, leave my home and take shelter at a public tornado shelter and leave my home with no destination in mind, simply to get out of the path of the tornado. The *vicarious experience* was positively correlated with *advisory 5 protective action* - monitor TV or radio (Q7) (r = .24, p <.01). This finding indicates when the *vicarious experience* is high, the participants are more likely to monitor TV or radio.

Risk perception: *advisory 5 risk perception was* negatively correlated with *advisory 5 protective action - ignore/continue what I am doing* (Q5) (r = -.32, p <.01). This finding indicates when *risk perception* is low, the participants are more likely to ignore watch or warning/continue what they are doing. *Advisory 5 risk perception was* positively correlated with *Advisory 5 protective action* - protect/secure private property (Q6) (r = .39, p <.01), *protective action - monitor TV or radio* (Q7) (r = .41, p <.01), *protective action - stay home and move to an interior room in the home* (Q8) (r = .30, p <.01), *protective action - leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house* (Q9) (r = .22, p <.01) and *protective action - leave my home and take shelter at a public tornado shelter* (Q10) (r = .24, p <.01). This finding indicates when *risk perception* is high, the participants are more likely to protect/secure private property, monitor TV or radio, stay home and move to an interior room in the home, leave their home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house, and leave their home and take shelter at a public tornado shelter.

Table 45. Correlations among experience, Advisory5 risk perception, and Advisory5 protective action

Variables	1	2	3	4	5	6	7	8	9	10	11	12
1. Direct experience	-											
2. Indirect experience	.64**	-										
3. Vicarious experience	.50**	.49**	-									
4. Life experience	.27**	.35**	.29**	-								
5. Adv5 risk perception	-.02	-.07	.07	.03	-							
6. Adv5 protective action Q5	-.07	-.03	-.22**	-.08	-.32**	-						
7. Adv5 protective action Q6	.04	.08	.11	.13*	.39**	-.11	-					
8. Adv5 protective action Q7	.17**	.19**	.24**	.16**	.41**	-.15*	.61**	-				
9. Adv5 protective action Q8	.10	.15*	.07	.06	.30**	-.01	.45**	.47**	-			
10. Adv5 protective action Q9	.01	.03	-.08	-.02	.22**	.01	.27**	.33**	.08	-		
11. Adv5 protective action Q10	-.11	-.14*	-.19**	-.07	.24**	.08	.17**	.14*	.02	.70**	-	
12. Adv5 protective action Q11	-.17**	-.13*	-.21**	-.11	.02	.37**	-.13*	-.09	.06	.23**	.39**	-

**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed)
Q5 = Ignore/continue what I am doing, Q6 = Protect / secure private property Q7 = Monitor TV or radio, Q8 = Stay home and move to an interior room in the home, Q9 = Leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house, Q10 = Leave my home and take shelter at a public tornado shelter, Q11 = Leave my home with no destination in mind, simply to get out of the path of the tornado

Correlation analysis was used to answer TELERQ6 (*What are the correlation among tornado experience, tornado risk information click count, and click duration under advisory 1?*); the results are presented in Table 46.

Direct experience: *the direct experience* was negatively correlated with *advisory 1 polygon plus location click count* ($r = -.16$, $p < .01$), *polygon plus track-line click count* ($r = -.15$, $p < .01$), *polygon plus track-line click duration* ($r = -.18$, $p < .01$) and *polygon plus probability click duration* ($r = -.12$, $p < .05$). This finding indicates when the *direct experience* is low, the participants are more likely to have *advisory 1 polygon plus location click count*, *polygon plus track-line click count*, *polygon plus track-line click duration,* and *polygon plus probability click duration*.

Indirect experience: *the indirect experience* was negatively correlated with *advisory 1 polygon only click count* ($r = -.15$, $p < .05$), *polygon plus location click count* ($r = -.21$, $p < .01$), *polygon plus track-line click count* ($r = -.16$, $p < .01$), *polygon plus probability click count* ($r = -.20$, $p < .01$), and *polygon plus track-line click duration* ($r = -.15$, $p < .05$). This finding indicates when the *indirect experience* is low, the participants are more likely to have *advisory 1 polygon only click count*, *polygon plus location click count*, *polygon plus track-line click count*, *polygon plus probability click count*, and *polygon plus track-line click duration.*

Life experience: *the life experience* was positively correlated with *Advisory 1 polygon plus radar click duration* ($r = .1$, $p < .05$). This finding indicates when the *life experience* is low, the participants are less likely to have *advisory 1 polygon plus radar click duration*.

Table 46. Correlations among experience, Advisory 1polygon click count, and Advisory1polygon click duration

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Direct experience	-													
2. Indirect experience	.64**	-												
3. Vicarious experience	.50**	.49**	-											
4. Life experience	.27**	.35**	.29**	-										
5. Advisory1 polygon only click (c)	-.08	-.15*	.05	.05	-									
6. Advisory1 polygon plus location click (c)	-.16**	-.21**	-.04	.07	.65**	-								
7. Advisory1 polygon plus tack-line click (c)	-.15**	-.16**	-.03	.09	.58**	.73**	-							
8. Advisory1 polygon plus probability click (c)	-.10	-.20**	-.01	.03	.54**	.66**	.78**	-						
9. Advisory1 polygon plus radar click (c)	-.60	-.09	-.04	.06	.38**	.62**	.61**	.61**	-					
10. Advisory1 polygon only click (d)	-.09	-.11	.01	-.02	.42**	.33**	.26**	.31**	.08	-				
11. Advisory1 polygon plus location click (d)	-.08	-.08	-.00	-.02	.29**	.41**	.28**	.29**	.08	.63**	-			
12. Advisory1 polygon plus tack-line click (d)	-18**	-.15*	.02	.05	.41**	.36**	.45**	.38**	.08	.57**	.63**	-		
13. Advisory1 polygon plus probability click (d)	-.12*	-.09	-.06	.02	.25**	.27**	.26**	.38**	.05	.48**	.60**	.56**	-	
14. Advisory1 polygon plus radar click (d)	-.07	-.10	.02	.11*	.29**	.34**	.27**	.35**	.26**	.54**	.49**	.52**	.44**	-

**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed)

Correlation analysis was used to answer TELERQ7 (*What are the correlation among tornado experience, tornado risk information click count, and click duration under advisory 2?*); the results are presented in Table 47.

Direct experience: the *direct experience* was negatively correlated with *advisory 2 polygon plus probability click count* (r = -.13, p <*.05*). This finding indicates when the *direct experience* is low, the participants are more likely to have *advisory 1 polygon plus probability click count*.

Indirect experience: the *indirect experience* was negatively correlated with *Advisory 2* polygon only click count (r = -.15, p <*.05*), *polygon plus location click count* (r = -.13, p <*.05*), *track-line click count* (r = -.12, p <*.01*), *polygon plus probability click count* (r = -.21, p <*.01*), *polygon plus radar click count* (r = -.12, p <*.05*), and *polygon plus location click duration* (r = -.12, p <*.01*). This finding indicates when the *indirect experience* is low, the participants are more likely to have *advisory 2 polygon only click count*, *polygon plus location click count*, *track-line click count*, *polygon plus probability click count*, *polygon plus radar click count*, and *polygon plus location click duration*.

Vicarious and life experiences: the *vicarious* and *life experiences* were not significantly correlated with *Advisory 2 tornado risk information click count and duration*.

Table 47. Correlations among experience, Advisory2 polygon click count, and Advisory2 polygon click duration

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Direct experience	-													
2. Indirect experience	.64**	-												
3. Vicarious experience	.50**	.49**	-											
4. Life experience	.27**	.35**	.29**	-										
5. Advisory2 polygon only click (c)	-.09	-.15*	-.05	-.03	-									
6. Advisory2 polygon plus location click (c)	-.08	-.15*	-.00	.02	.71**	-								
7. Advisory2 polygon plus tack-line click (c)	-.11	-.12**	-.05	.03	.58**	.83**	-							
8. Advisory2 polygon plus probability click (c)	-.13*	-.21**	.04	-.02	.56**	.66**	.50**	-						
9. Advisory2 polygon plus radar click (c)	-.06	-.12*	.04	-.04	.34**	.47**	.33**	.62**	-					
10. Advisory2 polygon only click (d)	-.11	-.08	.03	.08	.51**	.47**	.43**	.49**	.31**	-				
11. Advisory2 polygon plus location click (d)	-.02	-.12*	.05	.10	.36**	.58**	.49**	.44**	.20**	.60**	-			
12. Advisory2 polygon plus tack-line click (d)	-07	-.03	.02	.10	.42**	.64**	.76**	.43**	.24**	.61**	.64**	-		
13. Advisory2 polygon plus probability click (d)	-.08	-.10	.09	.05	.41**	.43**	.45**	.60**	.22**	.51**	.50**	.55**	-	
14. Advisory2 polygon plus radar click (d)	-.01	-.02	.04	.02	.22**	.25**	.16**	.31**	.46**	.43**	.31**	.29**	.35**	-

**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed)

Correlation analysis was used to answer TELERQ8 (*What are the correlation among tornado experience, tornado risk information click count, and click duration under advisory 3?*); the results are presented in Table 48. The four types of experiences were not significantly correlated with *Advisory 3 tornado risk information click count and duration*.

Table 48. Correlations among experience, Advisory3 polygon click count, and Advisory3 polygon click duration

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Direct experience	-													
2. Indirect experience	.64**	-												
3. Vicarious experience	.50**	.49**	-											
4. Life experience	.27**	.35**	.29**	-										
5. Advisory3 polygon only click (c)	-.07	-.10	-.04	-.02	-									
6. Advisory3 polygon plus location click (c)	-.09	-.08	-.04	.00	.91**	-								
7. Advisory3 polygon plus tack-line click (c)	-.09	-.11	-.03	-.01	.90**	.97**	-							
8. Advisory3 polygon plus probability click (c)	-.05	-.07	.06	.04	.69**	.71**	.73**	-						
9. Advisory3 polygon plus radar click (c)	.06	.02	.08	.05	.06	.00	.00	.19**	-					
10. Advisory3 polygon only click (d)	-.00	-.02	.05	-.02	.47**	.34**	.34**	.26**	.17**	-				
11. Advisory3 polygon plus location click (d)	.01	.01	.04	.04	.55**	.64**	.61**	.48**	.12*	.43**	-			
12. Advisory3 polygon plus tack-line click (d)	.01	-.02	.07	-.02	.37**	.42**	.51**	.42**	.00	.32**	.50**	-		
13. Advisory3 polygon plus probability click (d)	-.07	-.06	.06	-.01	.03	.05	.05	.19**	.01	.04	.08	.13*	-	
14. Advisory3 polygon plus radar click (d)	.10	.10	.10	.10	.02	-.02	.-02	.09	.54**	.20**	.07	.12*	.09	-

**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed)

Correlation analysis was used to answer TELERQ9 (*What are the correlation among tornado experience, tornado risk information click count, and click duration under advisory 4?*); the results are presented in Table 49.

Direct experience: the *direct experience* was negatively correlated with *advisory 4 polygon plus track-line click count* (r = -.16, p <*.01*) and *polygon plus probability click count* (r = -.15, p <*.01*). This finding indicates when the *direct experience* is low, the participants are more likely to have *Advisory 4 polygon plus track-line click count* and *polygon plus probability click count*.

Indirect experience: the *indirect experience* was negatively correlated with *Advisory 4 polygon plus track-line click count* (r = -.15, p <*.05*) and *polygon plus probability click count* (r = -.19, p <*.05*). This finding indicates when the *indirect experience* is low, the participants are more likely to have *Advisory 4 polygon plus track-line click count* and *polygon plus probability click count*.

Vicarious experience: the *vicarious experience* was not significantly correlated with *Advisory 4* tornado risk information click count and duration.

Life experience: the *life experience* was positively correlated with *Advisory 4 polygon plus location click duration* (r = .14, p <*.05).* This finding indicates when the *life experience* is low, the participants are less likely to have *advisory 4 polygon plus location click duration.*

Table 49. Correlations among experience, Advisory4 polygon click count, and Advisory4 polygon click duration

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Direct experience	-													
2. Indirect experience	.64**	-												
3. Vicarious experience	.50**	.49**	-											
4. Life experience	.27**	.35**	.29**	-										
5. Advisory4 polygon only click (c)	-.04	-.09	-.04	-.03	-									
6. Advisory4 polygon plus location click (c)	-.04	-.08	-.02	.06	.57**	-								
7. Advisory4 polygon plus tack-line click (c)	-.16**	-.15*	-.14*	-.06	.41**	.48**	-							
8. Advisory4 polygon plus probability click (c)	-.15**	-.19**	-.08	-.03	.35**	.36**	.51**	-						
9. Advisory4 polygon plus radar click (c)	.12	.08	.11	.07	.27**	.25**	.25**	.22**	-					
10. Advisory4 polygon only click (d)	-.04	-.03	-.01	-.04	.60**	.38**	.32**	.35**	.15**	-				
11. Advisory4 polygon plus location click (d)	.02	.01	.10	.14*	.22**	.57**	.22**	.15**	.16**	.37**	-			
12. Advisory4 polygon plus tack-line click (d)	-07	-.04	-.05	.-03	.20**	.32**	.55**	.28**	.13*	.39**	.29**	-		
13. Advisory4 polygon plus probability click (d)	-.11	-.09	.04	-.02	-.00	.03	.10	.28**	.06	.06	.06	.17**	-	
14. Advisory4 polygon plus radar click (d)	.14*	.10	.13*	.01	.02	.02	.10	.08	.55**	.14*	.14*	.14*	.61**	-

**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed)

Correlation analysis was used to answer TELERQ10 (*What are the correlation among tornado experience, tornado risk information click count, and click duration under advisory 5?*); the results are presented in Table 50. The four types of experiences were not significantly correlated with *Advisory 5 tornado risk information click count and duration*.

Table 50. Correlations among experience, Advisory5 polygon click count, and Advisory5 polygon click duration

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Direct experience	-													
2. Indirect experience	.64**	-												
3. Vicarious experience	.50**	.49**	-											
4. Life experience	.27**	.35**	.29**	-										
5. Advisory5 polygon only click (c)	-.10	-.11	-.01	-.04	-									
6. Advisory5 polygon plus location click (c)	.00	.01	.09	.06	.46**	-								
7. Advisory5 polygon plus tack-line click (c)	-.05	-.08	.07	-.08	.47**	.59**	-							
8. Advisory5 polygon plus probability click (c)	.03	.03	.11	.02	.20**	.33**	.33**	-						
9. Advisory5 polygon plus radar click (c)	.05	.03	.09	.02	.16**	.14*	.15**	.20**	-					
10. Advisory5 polygon only click (d)	-.05	-.02	.05	.03	.71**	.35**	.41**	.16**	.15*	-				
11. Advisory5 polygon plus location click (d)	-.02	.02	-.01	.10	.24**	.63**	.26**	.15**	.09	.26**	-			
12. Advisory5 polygon plus track-line click (d)	.05	.04	.09	-.04	.39**	.26**	.54**	.26**	.09	.38**	.20**	-		
13. Advisory5 polygon plus probability click (d)	-.08	-.07	.02	-.02	.07	.07	.13**	.28**	-.01	.07	.07**	.18**	-	
14. Advisory5 polygon plus radar click (d)	.09	-.01	.06	.05	.19**	.11	.19**	.08	.45**	.20**	.16**	.15*	.04	-

**. Correlation is significant at the 0.01 level (2-tailed)
*. Correlation is significant at the 0.05 level (2-tailed)

CHAPTER V

DISCUSSION

This study investigated how college students search for tornado risk information and select proper protective actions when risk information changes over time. Two methods were used to find the most preferred risk information. First, the comparison of click counts and click duration of risk information display was used in this study. Second, the respondent's self-reported risk information preference rating was analyzed. According to the comparison of click counts and click duration of tornado risk information display, people's preference for five types of risk information is significantly different. This study shows that participants spent higher click duration on *polygon plus radar image* and *polygon plus tornado strike probability* information among five kinds of risk information. The above-mentioned two displays have more visualized characteristics among five types of tornado risk displays. It is possible that the *polygon plus radar image display* includes weather color information, which enables participants to separate safe zone from an unsafe area. In addition, since *polygon plus tornado strike probability* included tornado occurrence rates such as 75%, 60%, 45%, 30%, and 15%, this information might allow participants to make an easier decision about tornado threats. Also, the results show that college students usually prefer visual information, which might help them to make an easy decision about tornado threat. These results confirmed the Mileti & Sorensen (1990) finding that changes in the nature and content of the warning had a significant impact on whether the public pay attention to the warning or not. Also, this study supported Nagele and Trainor's (2012) conclusion that storm-based warnings should focus on the optimization of the polygons themselves. Also, consistent with the click count and click duration, respondent's rating of self-reported preference of risk information shows the *polygon plus tornado strike probability and* the *polygon plus radar image* are the most preferred tornado risk information displays. And *Polygon only* information (3.06) was the least used among five types of risk information display.

Also, this study shows that participants' risk information display click counts are significantly different across the watch and warning group. Generally, a tornado watch is issued for broad areas where conditions exist for the development of tornado, while a warning is issued for highly localized areas where a tornado is imminent or has been detected on radar. In this experiment, the warning group was exposed to red-colored tornado polygon while the watch group was exposed to yellow-colored tornado polygon. Differences in the tornado polygon color, which indicate tornado risk, influenced students' decision-making. Also, this study shows that the risk perception between the watch group and the warning group is significantly different. Warning groups have substantially higher tornado risk precautions comparing watch groups. Armas (2006) studied how risk perceptions differ depending on gender, age, education, residential area and socioeconomic status, characteristics of the hazard, the difference of risk exposure, the difference of danger, and casualty awareness. However, Armas (2006) did not study the relationship between risk perception and the impact of student types such as international and U.S. domestic students. This study shows that international students have significantly higher tornado risk precautions comparing domestic students. These results confirmed Paton et al.'s (2000) conclusion that peoples have diverse interpretations of risk information.

This study used seven questions to compare the difference between international and domestic participants' protective actions when a tornado watch or warning is issued. According to results, when a tornado watch or warning is issued, international students are more likely to ignore it and continue what they were doing than the domestic student, leave home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family house than domestic students, leave home and take shelter at a public tornado shelter than domestic students, and leave home with no destination in mind, to get out of the path of the tornado than domestic students. However, when a tornado watch or warning is issued, domestic students are more likely to protect or secure their private property than international students, monitor TV or radio than international students, and stay home and move to an interior room in the home than international students.

Additionally, this study used seven questions to compare the difference between the watch and the warning group's protective actions when a tornado watch or warning is issued. The watch group from advisory 3 to advisory 5 is more likely to ignore it and continue what they were doing than warning group. Also, the warning group is more likely to protect or secure their private property than the watch group. The warning group is more likely to monitor TV or radio than the watch group. The watch group is more likely to stay home and move to an interior room in the home than the warning group. The warning group is more likely to leave home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family house than the watch group. Also, the warning group is more likely to leave home and take shelter at a public tornado shelter than the watch group. And the warning group is more likely to leave home with no destination in mind, to get out of the path of the tornado than the watch group.

Also, this study examined the correlation between four types of experiences, risk perception, and protective action. D*irect experience* was negatively correlated with *risk perception*. *Direct, indirect, and vicarious experiences* were positively correlated with *protective action*-monitor TV or radio (Q7). The *direct experience* was negatively correlated with *protective action*-leave my home and take shelter at a public tornado shelter (Q10), and *protective action*-leave my home with no destination in mind, simply to get out of the path of the tornado (Q11). The *indirect experience* was negatively correlated with *protective action*-leave my home and take shelter at a public tornado shelter (Q10). The *vicarious experience* was positively correlated with *advisory 1 protective action*-protect/secure private property (Q6). However, the *vicarious experience* was negatively correlated with *protective action*-ignore/continue what I am doing (Q5), *protective action*-leave my home and take shelter at a public tornado shelter (Q10), and *protective action*-leave my home with no destination in mind, to get out of the path of the tornado (Q11). This study could not confirm Paton et al. (2008)'s finding that experiencing volcanic hazards does not necessarily motivate people to respond to future volcanic cries.

This study shows that *risk perception was* negatively correlated with *protective action*-ignore/continue what I am doing (Q5). However, *Risk perception was* positively correlated with *protective action*-protect/secure private property (Q6), *protective action*-

monitor TV or radio (Q7), *protective action*-stay home and move to an interior room in the home (Q8), *protective action*-leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or family's house (Q9), and *protective action*-leave my home and take shelter at a public tornado shelter and *protective action* (Q10). These results did not support Bourque et al. (2012)'s finding that risk perception does not have a significant direct effect on preparedness behavior and that its effect is largely mediated by knowledge, perceived efficacy, and milling behavior. Also, these results did not confirm Johannesdottir et al. (2010)'s conclusion that the risk perception of the residents does not correspond to those tasked with the responsibility of developing the emergency and evacuation plans.

However, this study shows that *risk perception was* not significantly correlated with *protective action* Q11: leave my home with no destination in mind, to get out of the path of the tornado. This result confirmed Paton et al. (2000)'s finding that residents' various interpretations of risk information prevent the researcher from explaining a direct link between risk perception and preparedness.

The *direct experience* was negatively correlated with *polygon plus track-line click count* and *polygon plus probability click count*. The *indirect experience* was negatively correlated with polygon plus *track-line click count* and *polygon plus probability click count*. The *life experience* was positively correlated with *polygon plus location click duration and polygon plus radar click duration.* These results provide implications for the tornado warning response of college students in the state of Oklahoma. First, this study showed the significance of the tornado risk information display method to get higher warning policy compliance from people. Second, this study presented that international students are more vulnerable to tornado threats than U.S. domestic students.

CHAPTER VI

CONCLUSION

The results of this study provide evidence for international and U.S. domestic college students' ability to understand tornado risk information for the pre-decisional stage in the PADM model. During the pre-decisional phase, both international and domestic students prefer *polygon plus tornado strike probability* and *polygon plus radar over polygon only and polygon plus location* about approaching tornado. The results are more reliable because of the same results on the click counts, click durations, and the self-reported preference of tornado risk information. Also, both international and domestic students showed higher click count and longer click duration to tornado risk information in advisory four and advisory five than advisory one and advisory two. Click counts and click durations show mostly the same results, but there are some differences. For example, among the tornado risk information displays, college students prefer *gradient polygon plus tornado strike probability* (as indicated by higher click counts) and *gradient polygon plus radar image* (as indicated by longer click duration). Also, this study found that a learning effect happened during the experiment. During advisory 1, the mean for the *polygon only* click count is higher than any other risk information displays even if *the polygon only displays* did not provide extra risk information.

This effect might derive from the reason why the tornado polygon only display was placed in the first and most visible position on the information search screen. However, the preference for tornado risk information display changes over time. The results of advisory five show that the mean for the *polygon plus tornado strike probability* click count is the highest among other types of tornado risk information displays. This study shows that the difference in the way how tornado risk information was displayed can have a significant impact on how people can respond to the information. In addition to the five tornado information displays presented in this study, a more diverse tornado alert method can be used to make people a faster response to the tornado threat. However, the critical point is how to make people consider a traditional tornado alert method that is always familiar and mostly does not lead to tornado touchdown as a more real threat. As revealed in this empirical study, some factors should be considered to make the people respond more effectively from these tornado threats.

International students have higher tornado information preferences than domestic students. These results showed that the domestic student's relative familiarity with tornadoes might impede rapid response to tornado warnings. Also, international students have significantly higher tornado risk precautions comparing domestic students. This difference between international and domestic students suggested disaster authorities should make group-customized tornado warning policies. This study also showed how international and domestic college students took different protective actions from advisory 1 through advisory 5. International students are more likely to leave home to move to safe places than domestic students. Thus, disaster authorities at the university should notify international students of the location of shelter near their residence. Also, the authorities need to provide domestic students with education and training regarding the appropriate evacuation point when a tornado occurs. The demographic factors of the participants were also related to the level of protective action. This study shows that when family income is low, the participants are more likely to leave their homes and take shelter at a public tornado shelter when a tornado watch/warning is issued. This result may be because there is no shelter installed in low-income households, so education and training will be necessary to help students of low-income families know where public shelter is.

The finding showed how people responded to two other types of tornado threats- watch and warning. The warning group had higher tornado risk precautions than the watch group from advisory 1 through advisory 5. The fact that the warning group's risk perception is higher than the watch group shows the importance of the timing of the warning or warning issuance by the disaster authorities. This study indicated the time of publication of the warning might affect student's risk precautions. This study also showed how people's previous experience affect their protective actions. When direct, indirect, and vicarious experience is high, the participants are more likely to monitor TV or radio. Ensuring that students have a direct tornado experience is not in the realm of human control. However, students can enhance their indirect experiences if they participate in relief efforts or volunteer works after a disaster. Also, the student can increase their vicarious experience when they have more exposure to a media report about a tornado that has occurred in other places. Therefore, the disaster authorities need to provide students with the opportunity to gain this indirect and vicarious experience by offering disaster NGO works opportunities and tornado-related education and training materials.

Additionally, this research study shows how the participant's risk perception affects the protective action. When risk perception is high, the participants are more likely to take protective actions such as protect/secure their property, monitor TV or radio, move to an interior room in the home, seeking shelter. Thus, university emergency managers should encourage students to participate in the program through the development of various activities and training programs that can improve student's risk perception of disasters.

The experimental study showed a meaningful examination of how to achieve more effective policy effects when people with different prior experiences, risk perceptions, and demographic backgrounds were simultaneously informed of the tornado risk information. The results of this study will suggest directions for how policymakers working in the fields of emergency management agency, fire departments, and university authorities should provide disaster risk information for various disasters, including but not limited to tornadoes.

Although this study contributed to the discovery of factors that affect the development of emergency management, it has several limitations. First, five types of visual tornado risk information display and verbal messages were used for this study. However, it would be better to use various tornado information methods that allow participants to get engrossed in this experimental setting. For example, it would be better for researchers to use siren for their study because it is the most prominent warning method in Oklahoma. Second, it is a test, which means the modification of measurement that result from a reaction to the process of measurement. This happens even when a researcher utilized different but similar measures. Participants saw advisory1 through advisory five that are different but can be considered the same, and thus testing can be considered as a threat to internal validity. Third, only Oklahomans who are used to tornado alert participated in this study. It is common for Oklahomans to have more experience with tornado warnings and watches compared to residents in other states in the U.S. Thus, they have more sensationalization on the media. It would be better to distinguish the difference between Oklahomans and other state residents who are less susceptible to a tornado threat. Fourth, since this study was conducted on college students, it is difficult to generalize the results of this study to American citizens. Therefore, it is necessary to expand the scope of research participation from college students to more diverse classes. Fifth, international students lacked language proficiency compared to U.S. domestic students. So, international students may not have enough understanding of how this experimental research is conducted compared to domestic students. Differences could arise between international and domestic students in their knowledge of this type of empirical study. If the translator who could interpret languages in each country was included in this experiment, more accurate experimental data could be obtained even when the researcher was in the English Language Institute. Sixth, most of the data in this experimental study were done through quantitative analysis. However, if qualitative analysis methods were added, it would be possible to get more deep perspectives from the participants. Last but not least, this experimental study was conducted through the standpoint of fire and emergency managers. However, if the aspects from various field men such as the Meteorological Agency staff, television weatherman, education expert, and psychologist were combined, a more realistic experimental environment could have been produced.

Overall, the core value of this study has been to test tornado risk information preference, tornado risk perception, protective action, and tornado experience among international and U.S. domestic college students. The international and U.S. domestic college students could provide significant data for this topic. However, it is necessary to consider how international students' lack of English proficiency may have affected the results of these experiments. In the future, the researcher should consider the characteristics of international student who lack the language proficiency. Also, researchers should consider Oklahoman who are accustomed to tornado alerts compared to other state residents. That is to say, researchers need to keep "frequency lead to lack of fear" in mind and should include an experimental design that can measure those differences. Besides, it is necessary to include not only the college students who participated in this study but also various types of people as study participants to generalize these findings. The *DynaSearch* program was used as an efficient tool to conduct this experiment. However, the new version of the *DynaSearch* program, if it will include multiple video, sound effects, and virtual reality, can not only make participants more immersed in this experiment, but also further maximize the internal validity of this experiment. As a result, this systematic *DynaSearch* program will significantly assist in the development of various policy development as well as education and training contents that can reduce the number of tornado casualties in the United States.

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APPENDIX A: *DynaSearch* Questionnaire

Consent

Statement of Informed Consent

I understand that I am one of students participating in this study during the fall semester of 2019. The purpose of this experimental study is to explore relationship between tornado risk information and people's protective action preference. My participation will include tracking simulated tornado event with five weather advisories. This research study will last up to 60 minutes of my time.

The personal benefit for my participation is to learn more about tornado risk information and protective action decision. I understand that my participation is voluntary. I can stop my participation at any time simply by logging out the *DynaSearch* program. Withdrawal from the study at any step of the research process will not affect my relationship with the researchers or Oklahoma State University.

Participation in this study results in no predictable psychological or physical risk or discomfort. Participants' answers to the test questions will be stored securely at the Fire and Emergency Management Administration program office (Rm 505, Engineering North).

If I have any questions about this study, I may contact the investigator Ph.D. student Seongchul Choi (Rm 505, Engineering North, seongchul.choi@okstate.edu).

I understand this research study has been reviewed and approved by Oklahoma State University Institutional Review Board. If I have any research-related issues or questions regarding my subject's rights, I can contact Oklahoma State University IRB by calling (405) 744-3377 or emailing IRB@okstate.edu.

I have read and understood the explanation supplied to me. I have answered all my questions satisfactorily. I am presenting that I voluntarily agree to participate in this study by clicking "**CONTINUE**".

Continue

_DS_0082

Instruction

In this study, you will act as an individual in your house who receives tornado threat information. You will have to report your risk perception and decide the likelihood of taking protective action decisions after you receive tornado threat information. You will also be asked to report your feedback to this experimental study, your tornado experience and your demographic information.

In the following information screens, you will see five tornado advisories. Each tornado advisory will show you a tornado Information map of Stillwater and its surrounding areas.

You will need to get the tornado information you need from the information screen and judge the likelihood that a tornado will strike your community in the following questionnaire screen.

You will enter your judgments of risk perception, your protective action decisions, feedback to this experimental study, and tornado experience on several questionnaire screens that will be presented after tornado advisories.

The followings are information on how to use the tornado advisory screen and how you can use the questionnaire screen to report your risk perception, protective action decision, feedback to the experiment, and tornado experience. Please read through it carefully. You will also see a video instruction about how to operate the system in the next screen.

A. At the top of each tornado advisory screen, you will see a text box containing a short instruction and the time and date this advisory is issued.

B. At the center of the screen, you will find a map and its Legend box (the table right below the map). These maps provide visual representations of tornado watch / warning polygon, a polygon plus location, a polygon plus storm track-line, a polygon plus tornado strike probability, and the polygon plus radar image. When the tornado advisory screen first appears, the map will only show the geography of the area. However, you can get information about the current tornado event by moving the cursor to the corresponding cell in the Legend table and clicking the mouse's left key to reveal the information you want. The Legend table allows you to see five critical tornado event displays.

1. The **POLYGON** only button shows you the current location of the watch / warning polygon.
2. The **POLYGON plus LOCATION** button shows you the current location of the watch / warning polygon and your location.
3. The **POLYGON plus TRACK-LINE** button shows you the current location of the watch / warning polygon and moving direction of tornado together.
4. The **POLYGON plus PROBABILITY** button shows you the current location of the watch / warning polygon and probability of tornado occurrence together.
5. The **POLYGON plus RADAR** button shows you the current location of the watch / warning polygon and radar image together.

C. Please use your mouse's left key to click on the cells in the Legend Table to reveal the graphic information on the map. The information will remain visible as long you hold on your mouse's left key down. Once you release the key, the information will disappear. You can always click a legend element again if you want to see that information another time.

D. After getting the information you need from the tornado Information Screen, you should click the **DONE** button and go to the Questionnaire Screen. There you will find four sets of questions.

1. If there is a question that you prefer not to respond, you can : _DS_0082

2. The first set of questions will ask you for your estimates of the likelihood that the tornado will strike your community. Also, the first set of questions will ask you for your judgments about the likelihood that you would make different protective action decision.
3. The second set of questions will ask you for your feedback to this experimental study.
4. The third set of questions will ask you for your tornado experience.
5. The fourth set of questions will ask you for your demographic characteristics.

E. There is a time limit of ***three minutes*** on each tornado advisory so you should think carefully about what information you want to view. Within those three minutes, you may view as much or as little information as you choose. Once you have gotten all of the information you want from the tornado advisory, you can click the ***DONE*** button and move on to the questionnaire page. However, once you click the ***DONE*** button you cannot go back and recheck the information from the tornado advisories. That makes it important to remember the tornado information that you need.

F. If you have any problems with the program during the experiment, **stop immediately** and email us about your problems. You can find our emails in the recruitment email that you received earlier. Please do not fix the problem yourself.

G. In the next screen you will see a Youtube video that shows you how to operate ***DynaSearch*** program. It is a 2-minute video. Please watch it before you click **CONTINUE**.

Continue

_DS_0082

DynaSearch Video Instruction

Welcome to the DynaSearch video instruction page. Please watch the video below before continuing to the next page.

When you finished watching the video, please click on **CONTINUE** and start the Experiment.

Continue

_DS_0082

Instruction

Advisory 1: It is 2:00PM, on March 3, 2020. This is the information search page. This page shows you the tornado threat information. Please click on the Legend Window to display the graphic tornado threat information.

Clock

2:54 remaining.

Tornado risk information

Tornado risk information

Polygon only | Polygon plus location | Polygon plus trackline | Polygon plus probability | Polygon plus radar image

Done

_DS_0082

Risk Perception and Protective Action Response

Please fill out the following questionnaire. Required questions are marked with an asterix "*". If present, sections can be expanded by clicking on the respective titlebars.

Click submit when done to advance to the next section.

This section asks you questions about your tornado risk perception and protective action based on the information in the previous tornado advisory. Please click on the section title to show the questions.

A. Risk Perception Question

Based on the previous tornado advisory, please decide the likelihood of you taking the following risk perception.

A-1. How likely do you think a tornado will cause significant damage to your home or apartment?

- Extremely unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Extremely likely

A-2. How likely do you think a major tornado will cause significant damage to your property?

- Extremely unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Extremely likely

A-3. How likely do you think a major tornado will cause injury to you or members of your family?

- Extremely unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Extremely likely

A-4. How likely do you think a major tornado will disrupt your education or empl _DS_0082

Extremely unlikely
Somewhat unlikely
Neutral
Somewhat likely
Extremely likely

B. Protective Action Question

The following questions are meant to measure protective action.

Based on the previous tornado advisory, please decide the likelihood of you taking the following protective action.

When a tornado watch / warning is issued, what is your response?

B-1. Ignore / continue what I am doing.

Extremely unlikely
Somewhat unlikely
Neutral
Somewhat likely
Extremely likely

B-2. Protect / secure private property. Have your doors, windows, and garage doors closed.

Extremely unlikely
Somewhat unlikely
Neutral
Somewhat likely
Extremely likely

B-3. Monitor TV or radio.

Extremely unlikely
Somewhat unlikely
Neutral
Somewhat likely
Extremely likely

B-4. Stay home and move to an interior room in the home (e.g. a closet, a bathtub).

Extremely unlikely
Somewhat unlikely
Neutral
Somewhat likely
Extremely likely

B-5. Leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or families' house.

Extremely unlikely
Somewhat unlikely
Neutral

_DS_0082

Somewhat likely
Extremely likely

B-6. Leave my home and take shelter at a public tornado shelter.

Extremely unlikely
Somewhat unlikely
Neutral
Somewhat likely
Extremely likely

B-7. Leave my home with no destination in mind, simply to get out of the path of the tornado.

Extremely unlikely
Somewhat unlikely
Neutral
Somewhat likely
Extremely likely

Submit

Instruction

Advisory 2: 10 minutes has passed. It is 2:10PM, on March 3, 2020. This is the information search page. This page shows you the tornado threat information. Please click on the Legend Window to display the graphic tornado threat information.

Clock

2:56 remaining.

Tornado risk information

Tornado risk information

Polygon only	Polygon plus location	Polygon plus trackline	Polygon plus probability	Polygon plus radar image

Done

_DS_0082

Risk Perception and Protective Action Response

Please fill out the following questionnaire. Required questions are marked with an asterix "*". If present, sections can be expanded by clicking on the respective titlebars.

Click submit when done to advance to the next section.

This section asks you questions about your tornado risk perception and protective action based on the information in the previous tornado advisory. Please click on the section title to show the questions.

A. Risk Perception Question

Based on the previous tornado advisory, please decide the likelihood of you taking the following risk perception.

A-1. How likely do you think a tornado will cause significant damage to your home or apartment?

- Extremely unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Extremely likely

A-2. How likely do you think a major tornado will cause significant damage to your property?

- Extremely unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Extremely likely

A-3. How likely do you think a major tornado will cause injury to you or members of your family?

- Extremely unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Extremely likely

A-4. How likely do you think a major tornado will disrupt your education or empl _DS_0082

- Extremely unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Extremely likely

B. Protective Action Question

The following questions are meant to measure protective action.

Based on the previous tornado advisory, please decide the likelihood of you taking the following protective action.

When a tornado watch / warning is issued, what is your response?

B-1. Ignore / continue what I am doing.

- Extremely unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Extremely likely

B-2. Protect / secure private property. Have your doors, windows, and garage doors closed.

- Extremely unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Extremely likely

B-3. Monitor TV or radio.

- Extremely unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Extremely likely

B-4. Stay home and move to an interior room in the home (e.g. a closet, a bathtub).

- Extremely unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Extremely likely

B-5. Leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or families' house.

- Extremely unlikely
- Somewhat unlikely
- Neutral

_DS_0082

○ Somewhat likely
○ Extremely likely

B-6. Leave my home and take shelter at a public tornado shelter.

○ Extremely unlikely
○ Somewhat unlikely
○ Neutral
○ Somewhat likely
○ Extremely likely

B-7. Leave my home with no destination in mind, simply to get out of the path of the tornado.

○ Extremely unlikely
○ Somewhat unlikely
○ Neutral
○ Somewhat likely
○ Extremely likely

Submit

Instruction

Advisory 3: Another 10 minutes has passed. It is 2:20PM, on March 3, 2020. This is the information search page. This page shows you the tornado threat information. Please click on the Legend Window to display the graphic tornado threat information.

Clock

2:55 remaining.

Tornado risk information

Tornado risk information

Polygon only	Polygon plus location	Polygon plus trackline	Polygon plus probability	Polygon plus radar image

Done

_DS_0082

Risk Perception and Protective Action Response

Please fill out the following questionnaire. Required questions are marked with an asterix "*". If present, sections can be expanded by clicking on the respective titlebars.

Click submit when done to advance to the next section.

This section asks you questions about your tornado risk perception and protective action based on the information in the previous tornado advisory. Please click on the section title to show the questions.

A. Risk Perception Question

Based on the previous tornado advisory, please decide the likelihood of you taking the following risk perception.

A-1. How likely do you think a tornado will cause significant damage to your home or apartment?

- Extremely unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Extremely likely

A-2. How likely do you think a major tornado will cause significant damage to your property?

- Extremely unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Extremely likely

A-3. How likely do you think a major tornado will cause injury to you or members of your family?

- Extremely unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Extremely likely

A-4. How likely do you think a major tornado will disrupt your education or empl _DS_0082

◯ Extremely unlikely
◯ Somewhat unlikely
◯ Neutral
◯ Somewhat likely
◯ Extremely likely

B. Protective Action Question

The following questions are meant to measure protective action.

Based on the previous tornado advisory, please decide the likelihood of you taking the following protective action.

When a tornado watch / warning is issued, what is your response?

B-1. Ignore / continue what I am doing.

◯ Extremely unlikely
◯ Somewhat unlikely
◯ Neutral
◯ Somewhat likely
◯ Extremely likely

B-2. Protect / secure private property. Have your doors, windows, and garage doors closed.

◯ Extremely unlikely
◯ Somewhat unlikely
◯ Neutral
◯ Somewhat likely
◯ Extremely likely

B-3. Monitor TV or radio.

◯ Extremely unlikely
◯ Somewhat unlikely
◯ Neutral
◯ Somewhat likely
◯ Extremely likely

B-4. Stay home and move to an interior room in the home (e.g. a closet, a bathtub).

◯ Extremely unlikely
◯ Somewhat unlikely
◯ Neutral
◯ Somewhat likely
◯ Extremely likely

B-5. Leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or families' house.

◯ Extremely unlikely
◯ Somewhat unlikely
◯ Neutral

_DS_0082

Somewhat likely

Extremely likely

B-6. Leave my home and take shelter at a public tornado shelter.

Extremely unlikely

Somewhat unlikely

Neutral

Somewhat likely

Extremely likely

B-7. Leave my home with no destination in mind, simply to get out of the path of the tornado.

Extremely unlikely

Somewhat unlikely

Neutral

Somewhat likely

Extremely likely

Submit

Instruction

Advisory 4: Another 10 minutes has passed. It is 2:30PM, on March 3, 2020. This is the information search page. This page shows you the tornado threat information. Please click on the Legend Window to display the graphic tornado threat information.

Clock

2:57 remaining.

Tornado risk information

Tornado risk information

Polygon only | Polygon plus location | Polygon plus trackline | Polygon plus probability | Polygon plus radar image

Done

_DS_0082

Risk Perception and Protective Action Response

Please fill out the following questionnaire. Required questions are marked with an asterix "*". If present, sections can be expanded by clicking on the respective titlebars.

Click submit when done to advance to the next section.

This section asks you questions about your tornado risk perception and protective action based on the information in the previous tornado advisory. Please click on the section title to show the questions.

A. Risk Perception Question

Based on the previous tornado advisory, please decide the likelihood of you taking the following risk perception.

A-1. How likely do you think a tornado will cause significant damage to your home or apartment?

- Extremely unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Extremely likely

A-2. How likely do you think a major tornado will cause significant damage to your property?

- Extremely unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Extremely likely

A-3. How likely do you think a major tornado will cause injury to you or members of your family?

- Extremely unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Extremely likely

A-4. How likely do you think a major tornado will disrupt your education or empl _DS_0082

- Extremely unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Extremely likely

B. Protective Action Question

The following questions are meant to measure protective action.

Based on the previous tornado advisory, please decide the likelihood of you taking the following protective action.

When a tornado watch / warning is issued, what is your response?

B-1. Ignore / continue what I am doing.

- Extremely unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Extremely likely

B-2. Protect / secure private property. Have your doors, windows, and garage doors closed.

- Extremely unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Extremely likely

B-3. Monitor TV or radio.

- Extremely unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Extremely likely

B-4. Stay home and move to an interior room in the home (e.g. a closet, a bathtub).

- Extremely unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Extremely likely

B-5. Leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or families' house.

- Extremely unlikely
- Somewhat unlikely
- Neutral

_DS_0082

○ Somewhat likely
○ Extremely likely

B-6. Leave my home and take shelter at a public tornado shelter.

○ Extremely unlikely
○ Somewhat unlikely
○ Neutral
○ Somewhat likely
○ Extremely likely

B-7. Leave my home with no destination in mind, simply to get out of the path of the tornado.

○ Extremely unlikely
○ Somewhat unlikely
○ Neutral
○ Somewhat likely
○ Extremely likely

[Submit]

Instruction

Advisory 5: Another 10 minutes has passed. It is 2:40PM, on March 3, 2020. This is the information search page. This page shows you the tornado threat information. Please click on the Legend Window to display the graphic tornado threat information.

Clock

2:58 remaining.

Tornado risk information

Tornado risk information

Polygon only | Polygon plus location | Polygon plus trackline | Polygon plus probability | Polygon plus radar image

Done

_DS_0082

Risk Perception and Protective Action Response

Please fill out the following questionnaire. Required questions are marked with an asterix "*". If present, sections can be expanded by clicking on the respective titlebars.

Click submit when done to advance to the next section.

This section asks you questions about your tornado risk perception and protective action based on the information in the previous tornado advisory. Please click on the section title to show the questions.

A. Risk Perception Question

Based on the previous tornado advisory, please decide the likelihood of you taking the following risk perception.

A-1. How likely do you think a tornado will cause significant damage to your home or apartment?

- Extremely unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Extremely likely

A-2. How likely do you think a major tornado will cause significant damage to your property?

- Extremely unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Extremely likely

A-3. How likely do you think a major tornado will cause injury to you or members of your family?

- Extremely unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Extremely likely

A-4. How likely do you think a major tornado will disrupt your education or empl _DS_0082

◯ Extremely unlikely
◯ Somewhat unlikely
◯ Neutral
◯ Somewhat likely
◯ Extremely likely

B. Protective Action Question

The following questions are meant to measure protective action.

Based on the previous tornado advisory, please decide the likelihood of you taking the following protective action.

When a tornado watch / warning is issued, what is your response?

B-1. Ignore / continue what I am doing.

◯ Extremely unlikely
◯ Somewhat unlikely
◯ Neutral
◯ Somewhat likely
◯ Extremely likely

B-2. Protect / secure private property. Have your doors, windows, and garage doors closed.

◯ Extremely unlikely
◯ Somewhat unlikely
◯ Neutral
◯ Somewhat likely
◯ Extremely likely

B-3. Monitor TV or radio.

◯ Extremely unlikely
◯ Somewhat unlikely
◯ Neutral
◯ Somewhat likely
◯ Extremely likely

B-4. Stay home and move to an interior room in the home (e.g. a closet, a bathtub).

◯ Extremely unlikely
◯ Somewhat unlikely
◯ Neutral
◯ Somewhat likely
◯ Extremely likely

B-5. Leave my home and take shelter in either an above or below ground tornado shelter at a nearby neighbor, friend, or families' house.

◯ Extremely unlikely
◯ Somewhat unlikely
◯ Neutral

_DS_0082

- Somewhat likely
- Extremely likely

B-6. Leave my home and take shelter at a public tornado shelter.

- Extremely unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Extremely likely

B-7. Leave my home with no destination in mind, simply to get out of the path of the tornado.

- Extremely unlikely
- Somewhat unlikely
- Neutral
- Somewhat likely
- Extremely likely

Submit

General Question 1

Please fill out the following questionnaire. Required questions are marked with an asterix "*". If present, sections can be expanded by clicking on the respective titlebars.

Click submit when done to advance to the next section.

The following three sections ask you questions ask you questions about your experience on this experiment, your tornado experience and life experience and your demographic characteristics. please make sure you scroll down your screen to answer all the questions before you click on the SUBMIT button; and do not hit ENTER on your keyboard while you are answering the questions. Thank you!

A. Your experience on the experiment

A-1. To what extent did you use the gradient polygon image?

- Not at all
- Small extent
- Moderate extent
- Great extent
- Very great extent

A-2. To what extent did you use the gradient polygon image plus location?

- Not at all
- Small extent
- Moderate extent
- Great extent
- Very great extent

A-3. To what extent did you use the gradient polygon image plus trackline?

- Not at all
- Small extent
- Moderate extent
- Great extent
- Very great extent

A-4. To what extent did you use the gradient polygon image plus probability?

- Not at all
- Small extent
- Moderate extent

_DS_0082

- Great extent
- Very great extent

A-5. To what extent did you use the gradient polygon image plus radar image?

- Not at all
- Small extent
- Moderate extent
- Great extent
- Very great extent

Submit

General Question 2

Please fill out the following questionnaire. Required questions are marked with an asterix "*". If present, sections can be expanded by clicking on the respective titlebars.

Click submit when done to advance to the next section.

The following questions are meant to measure your tornado experience and life experience.

B. Your tornado experience (Direct experience)

B-1. Have you physically felt the tornado wind?

- No
- Yes

B-2. Have you ever received any tornado threat information (e.g. tornado watch / warning or seeing funnel cloud) and took protective action?

- No
- Yes

B-3. Have you ever experienced a tornado that caused damage to your home?

- No
- Yes

B-4. Have you ever experienced a tornado that caused disruption that prevented you from going to school or work place?

- No
- Yes

B-5. Have you ever experienced a tornado that caused injury to you or members of your immediate family (e.g. family who live with you)?

- No
- Yes

Submit

General Question 2

Please fill out the following questionnaire. Required questions are marked with an asterix "*". If present, sections can be expanded by clicking on the respective titlebars.

Click submit when done to advance to the next section.

The following questions are meant to measure your tornado experience and life experience.

B. Your tornado experience (Indirect experience)

B-6. Have you ever received any tornado threat information (e.g. tornado watch / warning or seeing funnel cloud) but did not take protective action?

- ○ No
- ○ Yes

B-7. Have you ever experienced a tornado that caused damage to property in your city?

- ○ No
- ○ Yes

B-8. Have you ever been involved in responding to tornado as a civil defense volunteer?

- ○ No
- ○ Yes

B-9. Have you ever assisted with relief efforts (e.g. collecting post-disaster funds; helping organize recovery assistance) after a tornado damage in your city?

- ○ No
- ○ Yes

B-10. Have you ever experienced transportation disruption that prevented you from going to school?

- ○ No
- ○ Yes

Submit

General Question 2

Please fill out the following questionnaire. Required questions are marked with an asterix "*". If present, sections can be expanded by clicking on the respective titlebars.

Click submit when done to advance to the next section.

The following questions are meant to measure your tornado experience and life experience.

B. Your tornado experience (Vicarious experience)

B-11. Have any of your friends, relatives, neighbors or coworkers that you know personally experienced a tornado that caused damage to their home?

- No
- Yes

B- 12. Have any of your friends, relatives, neighbors or coworkers that you know personally experienced a tornado that caused injury?

- No
- Yes

B-13. Have any of your friends, relatives, neighbors or coworkers that you know personally experienced a tornado that caused disruption that prevented them from going to school or work place?

- No
- Yes

B-14. Have any of your friends, relatives, neighbors or coworkers ever received a tornado threat information (e.g. tornado watch / warning or seeing funnel cloud) and took protection action?

- No
- Yes

B-15. Have you ever been exposed to media reports about tornadoes that have occurred on other places?

- No
- Yes

Submit

General Question 2

Please fill out the following questionnaire. Required questions are marked with an asterix "*". If present, sections can be expanded by clicking on the respective titlebars.

Click submit when done to advance to the next section.

The following questions are meant to measure your tornado experience and life experience.

B. Your tornado experience (Life experience)

B-16. Have you ever experienced a vehicle accident?

- No
- Yes

B-17. Have you ever experienced an infrastructure failure (e.g., power, telecommunications)?

- No
- Yes

B-18. Have you ever experienced an industrial hazard accident?

- No
- Yes

B-19. Have you ever experienced a serious health issue (e.g., illness, surgery, hospitalization)?

- No
- Yes

B-20. Have you ever experienced any other type of personal accident (e.g. crime, fire, traumatic event)?

- No
- Yes

Submit

General Question 3

Please fill out the following questionnaire. Required questions are marked with an asterix "*". If present, sections can be expanded by clicking on the respective titlebars.

Click submit when done to advance to the next section.

The following questions are meant to measure your demographic characteristics.

D. Your demographic characteristics

D-1. What is your age?

150 characters remaining

D-2. What is your sex?

- ○ Male
- ○ Female

D-3. What is your marital status?

- ○ Married
- ○ Single
- ○ Divorced
- ○ Widowed

D-4. To which of the following ethnic groups do you belong and identify?

- ○ African American
- ○ Asian / Pacific Islander
- ○ Caucasian
- ○ Hispanic
- ○ Native American
- ○ Mixed
- ○ Other

D-5. What is your highest education level? _DS_0082

- Less than high school
- High school graduate
- Some college/vocational school
- College freshmen
- College sophomore
- College junior
- College senior
- College graduate
- Graduate school
- English Language Institute student

D-6. What is your family's total income before taxes for the year of 2019?

- Less than $30,000
- $30,000 - 54,999
- $55,000 - 79,999
- $80,000 - 104,999
- $105,000 - 129,999
- More than $130,000

D-7. Do you own the place where you now live?

- No
- Yes

D-8. Do you rent the place where you now live?

- No
- Yes

D-9. Do you live on campus or university housing?

- No
- Yes

D-10. In which country is your high school located?

150 characters remaining

D-11. How many years have you lived in Oklahoma?

150 characters remaining

D-12. Are you U.S. citizen?

_DS_0082

◯ No
◯ Yes

D-13. Do you have any additional comments about the tornado hazard in Oklahoma?

150 characters remaining

D-14. If you wish to win the 10 dollars Amazon gift card, please give us your OSU email address. We will contact you if you are one of the winners (If you don't want to join the draw, please type "I do not wish to participate").

150 characters remaining

Submit

APPENDIX B: Survey Code Book

Category	Variables	Measure(type)	Value
Student ID	ID	Nominal(numeric)	1-2999
Weather notice	Watch/Warning	Nominal(numeric)	0 = Watch/1 = Warning
Student type	Inter/Dom	Nominal(numeric)	0 = International/1 = Domestic
Advisory 1 Risk perception	Adv1Q1	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 1 Risk perception	Adv1Q2	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 1 Risk perception	Adv1Q3	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 1 Risk perception	Adv1Q4	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 1 Protective action	Adv1Q5	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 1 Protective action	Adv1Q6	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 1 Protective action	Adv1Q7	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 1 Protective action	Adv1Q8	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely

			5 = Extremely likely
Advisory 1 Protective action	Adv1Q9	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 1 Protective action	Adv1Q10	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 1 Protective action	Adv1Q11	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 2 Risk perception	Adv2Q1	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 2 Risk perception	Adv2Q2	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 2 Risk perception	Adv2Q3	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 2 Risk perception	Adv2Q4	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 2 Protective action	Adv2Q5	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 2 Protective action	Adv2Q6	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 2 Protective action	Adv2Q7	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely

			5 = Extremely likely
Advisory 2 Protective action	Adv2Q8	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 2 Protective action	Adv2Q9	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 2 Protective action	Adv2Q10	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 2 Protective action	Adv2Q11	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 3 Risk perception	Adv3Q1	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 3 Risk perception	Adv3Q2	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 3 Risk perception	Adv3Q3	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 3 Risk perception	Adv3Q4	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 3 Protective action	Adv3Q5	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 3 Protective action	Adv3Q6	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely

			5 = Extremely likely
Advisory 3 Protective action	Adv3Q7	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 3 Protective action	Adv3Q8	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 3 Protective action	Adv3Q9	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 3 Protective action	Adv3Q10	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 3 Protective action	Adv3Q11	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 4 Risk perception	Adv4Q1	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 4 Risk perception	Adv4Q2	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 4 Risk perception	Adv4Q3	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 4 Risk perception	Adv4Q4	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 4 Protective action	Adv4Q5	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely

			5 = Extremely likely
Advisory 4 Protective action	Adv4Q6	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 4 Protective action	Adv4Q7	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 4 Protective action	Adv4Q8	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 4 Protective action	Adv4Q9	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 4 Protective action	Adv4Q10	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 4 Protective action	Adv4Q11	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 5 Risk perception	Adv5Q1	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 5 Risk perception	Adv5Q2	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 5 Risk perception	Adv5Q3	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 5 Risk perception	Adv5Q4	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely

			5 = Extremely likely
Advisory 5 Protective action	Adv5Q5	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 5 Protective action	Adv5Q6	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 5 Protective action	Adv5Q7	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 5 Protective action	Adv5Q8	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 5 Protective action	Adv5Q9	Ordinal (numeric)	1 to 5 (extremely unlikely to extremely likely)
Advisory 5 Protective action	Adv5Q10	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Advisory 5 Protective action	Adv5Q11	Ordinal (numeric)	1 = Extremely unlikely 2 = Somewhat unlikely 3 = Neutral 4 = Somewhat likely 5 = Extremely likely
Experience on the experiment	Gen1Q1	Ordinal (numeric)	1 = Not at all 2 = Small extent 3 = Moderate extent 4 = Great extent 5 = Very great extent
Experience on the experiment	Gen1Q2	Ordinal (numeric)	1 = Not at all 2 = Small extent 3 = Moderate extent 4 = Great extent 5 = Very great extent
Experience on the experiment	Gen1Q3	Ordinal (numeric)	1 = Not at all 2 = Small extent 3 = Moderate extent 4 = Great extent 5 = Very great extent

Experience on the experiment	Gen1Q4	Ordinal (numeric)	1 = Not at all 2 = Small extent 3 = Moderate extent 4 = Great extent 5 = Very great extent
Experience on the experiment	Gen1Q5	Ordinal (numeric)	1 = Not at all 2 = Small extent 3 = Moderate extent 4 = Great extent 5 = Very great extent
Direct tornado experience	Gen2Q1	Nominal(numeric)	0 = No 1 = Yes
Direct tornado experience	Gen2Q2	Nominal(numeric)	0 = No 1 = Yes
Direct tornado experience	Gen2Q3	Nominal(numeric)	0 = No 1 = Yes
Direct tornado experience	Gen2Q4	Nominal(numeric)	0 = No 1 = Yes
Direct tornado experience	Gen2Q5	Nominal(numeric)	0 = No 1 = Yes
Indirect tornado experience	Gen2Q6	Nominal(numeric)	0 = No 1 = Yes
Indirect tornado experience	Gen2Q7	Nominal(numeric)	0 = No 1 = Yes
Indirect tornado experience	Gen2Q8	Nominal(numeric)	0 = No 1 = Yes
Indirect tornado experience	Gen2Q9	Nominal(numeric)	0 = No 1 = Yes
Indirect tornado experience	Gen2Q10	Nominal(numeric)	0 = No 1 = Yes
Vicarious tornado experience	Gen2Q11	Nominal(numeric)	0 = No 1 = Yes
Vicarious tornado experience	Gen2Q12	Nominal(numeric)	0 = No 1 = Yes
Vicarious tornado experience	Gen2Q13	Nominal(numeric)	0 = No 1 = Yes

Vicarious tornado experience	Gen2Q14	Nominal(numeric)	0 = No 1 = Yes
Vicarious tornado experience	Gen2Q15	Nominal(numeric)	0 = No 1 = Yes
Life experience	Gen2Q16	Nominal(numeric)	0 = No 1 = Yes
Life experience	Gen2Q17	Nominal(numeric)	1 = No 2 = Yes
Life experience	Gen2Q18	Nominal(numeric)	0 = No 1 = Yes
Life experience	Gen2Q19	Nominal(numeric)	0 = No 1 = Yes
Life experience	Gen2Q20	Nominal(numeric)	0 = No 1 = Yes
Age	Gen3Q1	Nominal(string)	Open-ended
Sex	Gen3Q2	Nominal(numeric)	0 = Male 1 = Female
Marital status	Gen3Q3	Nominal(numeric)	1 = Married 2 = Single 3 = Divorced 4 = Widowed
Ethnic group	Gen3Q4	Nominal(numeric)	1 = African American 2 = Asian / Pacific islander 3 = Caucasian 4 = Hispanic 5 = Native American 6 = Mixed 7 = Other
Education level	Gen3Q5	Nominal(numeric)	1 = Less than high school 2 = High school graduate 3 = Some college/vocational school 4 = College freshman 5 = College sophomore 6 = College Junior 7 = College Senior 8 = College graduate 9 = Graduate school 10 = English Language Institute student
Family income	Gen3Q6	Nominal(numeric)	1 = less than $30,000 2 = $30,000 – 54,999 3 = $55,000 – 79,999 4 = $80,000 – 104,999 5 = 105,000 – 129,999 6 = More than $130,000
Home owner	Gen3Q7	Nominal(numeric)	0 = No 1 = Yes

Home renter	Gen3Q8	Nominal(numeric)	0 = No 1 = Yes
On campus/ university housing	Gen3Q9	Nominal(numeric)	0 = No 1 = Yes
High school place	Gen3Q10	Nominal(string)	Open-ended
Living year in OK	Gen3Q11	Nominal(string)	Open-ended
U.S. citizenship	Gen3Q12	Nominal(numeric)	0 = No 1 = Yes
Any comment	Gen3Q13	Nominal(string)	Open-ended
Email address for Gift card	Gen3Q14	Nominal(string)	Open-ended
Click count	Adv1_Poly_c	Scale(numeric)	Number of click
Click duration	Adv1_Poly_d	Scale(numeric)	Second of click
Click count	Adv1_PolyLoca_c	Scale(numeric)	Number of click
Click duration	Adv1_PolyLoca_d	Scale(numeric)	Second of click
Click count	Adv1_PolyTrack_c	Scale(numeric)	Number of click
Click duration	Adv1_PolyTrack_d	Scale(numeric)	Second of click
Click count	Adv1_PolyProb_c	Scale(numeric)	Number of click
Click duration	Adv1_PolyProb_d	Scale(numeric)	Second of click
Click count	Adv1_PolyRadar_c	Scale(numeric)	Number of click
Click duration	Adv1_PolyRadar_d	Scale(numeric)	Second of click
Click count	Adv2_Poly_c	Scale(numeric)	Number of click
Click duration	Adv2_Poly_d	Scale(numeric)	Second of click
Click count	Adv2_PolyLoca_c	Scale(numeric)	Number of click
Click duration	Adv2_PolyLoca_d	Scale(numeric)	Second of click
Click count	Adv2_PolyTrack_c	Scale(numeric)	Number of click
Click duration	Adv2_PolyTrack_d	Scale(numeric)	Second of click

Click count	Adv2_PolyProb_c	Scale(numeric)	Number of click
Click duration	Adv2_PolyProb_d	Scale(numeric)	Second of click
Click count	Adv2_PolyRadar_c	Scale(numeric)	Number of click
Click duration	Adv2_PolyRadar_d	Scale(numeric)	Second of click
Click count	Adv3_Poly_c	Scale(numeric)	Number of click
Click duration	Adv3_Poly_d	Scale(numeric)	Second of click
Click count	Adv3_PolyLoca_c	Scale(numeric)	Number of click
Click duration	Adv3_PolyLoca_d	Scale(numeric)	Second of click
Click count	Adv3_PolyTrack_c	Scale(numeric)	Number of click
Click duration	Adv3_PolyTrack_d	Scale(numeric)	Second of click
Click count	Adv3_PolyProb_c	Scale(numeric)	Number of click
Click duration	Adv3_PolyProb_d	Scale(numeric)	Second of click
Click count	Adv3_PolyRadar_c	Scale(numeric)	Number of click
Click duration	Adv3_PolyRadar_d	Scale(numeric)	Second of click
Click count	Adv4_Poly_c	Scale(numeric)	Number of click
Click duration	Adv4_Poly_d	Scale(numeric)	Second of click
Click count	Adv4_PolyLoca_c	Scale(numeric)	Number of click
Click duration	Adv4_PolyLoca_d	Scale(numeric)	Second of click
Click count	Adv4_PolyTrack_c	Scale(numeric)	Number of click
Click duration	Adv4_PolyTrack_d	Scale(numeric)	Second of click
Click count	Adv4_PolyProb_c	Scale(numeric)	Number of click
Click duration	Adv4_PolyProb_d	Scale(numeric)	Second of click
Click count	Adv4_PolyRadar_c	Scale(numeric)	Number of click
Click duration	Adv4_PolyRadar_d	Scale(numeric)	Second of click

Click count	Adv5_Poly_c	Scale(numeric)	Number of click
Click duration	Adv5_Poly_d	Scale(numeric)	Second of click
Click count	Adv5_PolyLoca_c	Scale(numeric)	Number of click
Click duration	Adv5_PolyLoca_d	Scale(numeric)	Second of click
Click count	Adv5_PolyTrack_c	Scale(numeric)	Number of click
Click duration	Adv5_PolyTrack_d	Scale(numeric)	Second of click
Click count	Adv5_PolyProb_c	Scale(numeric)	Number of click
Click duration	Adv5_PolyProb_d	Scale(numeric)	Second of click
Click count	Adv5_PolyRadar_c	Scale(numeric)	Number of click
Click duration	Adv5_PolyRadar_d	Scale(numeric)	Second of click
Click count	Poly_c	Scale(numeric)	Mean(Adv1Polyclick to Adv5Polyclick)
Click count	PolyLoca_c	Scale(numeric)	Mean(Adv1PolyLocaclick to Adv5PolyLocaclick)
Click count	PolyTrack_c	Scale(numeric)	Mean(Adv1PolyTrackclick to Adv5PolyTrackclick)
Click count	PolyProb_c	Scale(numeric)	Mean(Adv1PolyProbclick to Adv5PolyProbclick)
Click count	PolyRadar_c	Scale(numeric)	Mean(Adv1PolyRadarclick to Adv5PolyRadarclick)
Click duration	Poly_d	Scale(numeric)	Mean(Adv1Polyduration to Adv5Polyduration)
Click duration	PolyLoca_d	Scale(numeric)	Mean(Adv1PolyLocaduration to Adv5PolyLocaduration)
Click duration	PolyTrack_d	Scale(numeric)	Mean(Adv1PolyTrackduration to Adv5PolyTrackduration)
Click duration	PolyProb_d	Scale(numeric)	Mean(Adv1PolyProbduration to Adv5PolyProbduration)
Click duration	PolyRadar_d	Scale(numeric)	Mean(Adv1PolyRadarduration to Adv5PolyRadarduration)
Risk Perception	Adv1RiskPer	Scale(numeric)	Mean(Adv1Q1 to Adv1Q4)
Risk Perception	Adv2RiskPer	Scale(numeric)	Mean(Adv2Q1 to Adv2Q4)

Risk Perception	Adv3RiskPer	Scale(numeric)	Mean(Adv3Q1 to Adv3Q4)
Risk Perception	Adv4RiskPer	Scale(numeric)	Mean(Adv4Q1 to Adv4Q4)
Risk Perception	Adv5RiskPer	Scale(numeric)	Mean(Adv5Q1 to Adv5Q4)
Risk Perception	RiskPer	Scale(numeric)	Mean(Adv1RiskPer to Adv5RiskPer)
Protective Action	Adv1ProAct	Scale(numeric)	Mean(Adv1Q5 to Adv1Q11)
Protective Action	Adv2ProAct	Scale(numeric)	Mean(Adv2Q5 to Adv2Q11)
Protective Action	Adv3ProAct	Scale(numeric)	Mean(Adv3Q5 to Adv3Q11)
Protective Action	Adv4ProAct	Scale(numeric)	Mean(Adv4Q5 to Adv4Q11)
Protective Action	Adv5ProAct	Scale(numeric)	Mean(Adv5Q5 to Adv5Q11)
Protective Action	ProAct	Scale(numeric)	Mean(Adv1ProAct to Adv5ProAct)
Direct Experience	DirTorExp	Scale(numeric)	Mean(Gen2Q1 to Gen2Q5)
Indirect Experience	IndirTorExp	Scale(numeric)	Mean(Gen2Q6 to Gen2Q10)
Vicarious Experience	VicTorExp	Scale(numeric)	Mean(Gen2Q11 to Gen2Q15)
Tornado Experience	TorExp	Scale(numeric)	Mean(DirTorExp to VicTorExp)
Life Experience	LifeExp	Scale(numeric)	Mean(Gen2Q16 to Gen2Q20)
Education	EduNew	Nominal(numeric)	1 Less than high school = 9 2 High school graduate = 9 3 Some college/vocational school = 9 4 College freshmen = 1 5 College sophomore = 1 6 College junior = 2 7 College senior = 2 8 College graduate = 9 9 Graduate school =3 10 English Language institute student = 9
Education	Filter_$	Nominal(numeric)	EduNew < 9 (Filter)

Ethnicity	White/Nonwhite	Nominal(numeric)	1 African American = Nonwhite 2 Asian/Pacific islander = Nonwhite 3 Caucasian = White 4 Hispanic = Nonwhite 5 Native American = Nonwhite 6 Mixed = Nonwhite 7 Other = Nonwhite
Click count	Total click count	Scale(numeric)	Sum(Polygon only click count, polygon plus location click count, polygon plus track-line click count, polygon plus tornado strike probability click count, polygon plus radar click count)
Click duration	Total click duration	Scale(numeric)	Sum(Polygon only click duration, polygon plus location click duration, polygon plus track-line click duration, polygon plus tornado strike probability click duration, polygon plus radar click duration)

APPENDIX C: Statistical method

Measuring	RQ/RH	Dependent variable	Independent variable	Test
Information Search	ISRQ1-1	Tornado information preference (click count)	5 types of Information display	Repeated Measure ANOVA
	ISRQ1-2	Tornado information preference (click duration)	5 types of Information display	Repeated Measure ANOVA
	ISRQ2-1	Tornado information preference (click count)	Tornado alert type (watch, warning), 5 types of Information display	Two factor mixed design ANOVA
	ISRQ2-2	Tornado information preference (click duration)	Tornado alert type (watch, warning), 5 types of Information display	Two factor mixed design ANOVA
	ISRQ3-1_1	Tornado information preference (Adv1 click count)	Adv1 5 types of Information display	Repeated Measure ANOVA
	ISRQ3-1_2	Tornado information preference (Adv1 click duration)	Adv1 5 types of Information display	Repeated Measure ANOVA
	ISRQ3-2_1	Tornado information preference (Adv2 click count)	Adv2 5 types of Information display	Repeated Measure ANOVA
	ISRQ3-2_2	Tornado information preference (Adv2 click duration)	Adv2 5 types of Information display	Repeated Measure ANOVA
	ISRQ3-3_1	Tornado information preference (Adv3 click count)	Adv3 5 types of Information display	Repeated Measure ANOVA
	ISRQ3-3_2	Tornado information preference (Adv3 click duration)	Adv3 5 types of Information display	Repeated Measure ANOVA
	ISRQ3-4_1	Tornado information preference (Adv4 click count)	Adv4 5 types of Information display	Repeated Measure ANOVA
	ISRQ3-4_2	Tornado information preference (Adv4 click duration)	Adv4 5 types of Information display	Repeated Measure ANOVA
	ISRQ3-5_1	Tornado information preference (Adv5 click count)	Adv5 5 types of Information display	Repeated Measure ANOVA

	ISRQ3-5_2	Tornado information preference (Adv5 click duration)	Adv5 5 types of Information display	Repeated Measure ANOVA
	ISRQ4-1_1	Tornado information preference (click count)	Student type (international, domestic) * Control variable: demographic(age)	ANCOVA
	ISRQ4-1_2	Tornado information preference (click duration)	Student type (international, domestic) * Control variable: demographic(age)	ANCOVA
	ISRQ4-2_1	Tornado information preference (click count)	Student type (international, domestic) * Control variable: demographic(sex)	ANCOVA
	ISRQ4-2_2	Tornado information preference (click duration)	Student type (international, domestic) * Control variable: demographic(sex)	ANCOVA
	ISRQ4-3_1	Tornado information preference (click count)	Student type (international, domestic) * Control variable: demographic(marital status)	ANCOVA
	ISRQ4-3_2	Tornado information preference (click duration)	Student type (international, domestic) * Control variable: demographic(marital status)	ANCOVA
	ISRQ4-4_1	Tornado information preference (click count)	Student type (international, domestic) * Control variable: demographic(white/nonwhite)	ANCOVA
	ISRQ4-4_2	Tornado information preference (click duration)	Student type (international, domestic)	ANCOVA

			* Control variable: demographic(white/nonwhite)	
	ISRQ4-5_1	Tornado information preference (click count)	Student type (international, domestic) * Control variable: demographic(education)	ANCOVA
	ISRQ4-5_2	Tornado information preference (click duration)	Student type (international, domestic) * Control variable: demographic(education)	ANCOVA
	ISRQ4-6_1	Tornado information preference (click count)	Student type (international, domestic) * Control variable: demographic(family income)	ANCOVA
	ISRQ4-6_2	Tornado information preference (click duration)	Student type (international, domestic) * Control variable: demographic(family income)	ANCOVA
	ISRQ4-7_1	Tornado information preference (click count)	Student type (international, domestic) * Control variable: demographic(renter)	ANCOVA
	ISRQ4-7_2	Tornado information preference (click duration)	Student type (international, domestic) * Control variable: demographic(renter)	ANCOVA
	ISRQ4-8_1	Tornado information preference (click count)	Student type (international, domestic) * Control variable: demographic(on-campus/university housing)	ANCOVA

	ISRQ4-8_2	Tornado information preference (click duration)	Student type (international, domestic) * Control variable: demographic(on-campus/university housing)	ANCOVA
	ISRQ5	Tornado information preference (overall click count & duration)	Demographic(age, family income)	Correlation
Experience on the experiment	EERQ1	Use of five types of information		Cronbach's α test,
	EERQ2	Use of information in the experiment	Information type	Repeated Measure ANOVA
Risk Perception	RPRQ1-1	Risk perception	Student type (international, domestic) * Control variable: demographics(age)	ANCOVA
	RPRQ1-2	Risk perception	Student type (international, domestic) * Control variable: demographics(sex)	ANCOVA
	RPRQ1-3	Risk perception	Student type (international, domestic) * Control variable: demographics(marital status)	ANCOVA
	RPRQ1-4_1	Risk perception	Student type (international, domestic) * Control variable: demographics(white/nonwhite)	ANCOVA
	RPRQ1-4_2	Risk perception	Student type (international, domestic) * Control variable: demographics(ethnicity)	ANCOVA

	RPRQ1-5_1	Risk perception	Student type (international, domestic) * Control variable: demographics(education)	ANCOVA
	RPRQ1-5_2	Risk perception	Student type (international, domestic) * Control variable: demographics(new education)	ANCOVA
	RPRQ1-6	Risk perception	Student type (international, domestic) * Control variable: demographics(family income)	ANCOVA
	RPRQ1-7	Risk perception	Student type (international, domestic) * Control variable: demographics(renter)	ANCOVA
	RPRQ1-8	Risk perception	Student type (international, domestic) * Control variable: demographics(renter)	ANCOVA
	RPRH1-1	Adv1 Risk perception		Cronbach's α test
	RPRH1-2	Adv1 Risk perception	First advisory tornado alert type (watch, warning),	Independent sample t-test
	RPRH2-1	Adv2 Risk perception		Cronbach's α test
	RPRH2-2	Adv2 Risk perception	Second advisory tornado alert type (watch, warning), second advisory	Independent sample t-test
	RPRH3-1	Adv3 Risk perception		Cronbach's α test

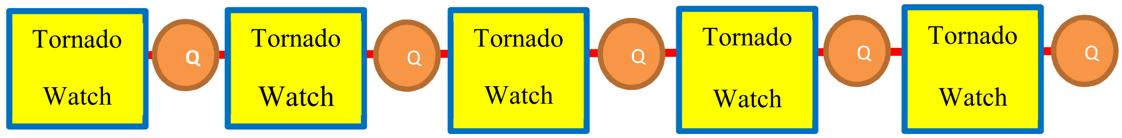
	RPRH3-2	Adv3 Risk perception	Third advisory tornado alert type (watch, warning), second advisory	Independent sample t-test
	RPRH4-1	Adv4 Risk perception		Cronbach's α test
	RPRH4-2	Adv4 Risk perception	Fourth advisory tornado alert type (watch, warning), second advisory	Independent sample t-test
	RPRH5-1	Adv5 Risk perception		Cronbach's α test
	RPRH5-2	Adv5 Risk perception	Fifth advisory tornado alert type (watch, warning), second advisory	Independent sample t-test
	RPRQ2	Risk perception	Demographics (age, family income)	Correlation
Protective Action	PARQ1	Adv1 Protective Action	Student type (international, domestic), Protective action type	Two factor mixed design ANOVA
	PARQ2	Adv2 Protective Action	Student type (international, domestic), Protective action type	Two factor mixed design ANOVA
	PARQ3	Adv3 Protective Action	Student type (international, domestic), Protective action type	Two factor mixed design ANOVA
	PARQ4	Adv4 Protective Action	Student type (international, domestic), Protective action type	Two factor mixed design ANOVA
	PARQ5	Adv5 Protective Action	Student type (international, domestic), Protective action type	Two factor mixed design ANOVA
	PARQ6	Adv1 Protective Action	Alert type (watch, warning), Protective action type	Two factor mixed design ANOVA
	PARQ7	Adv2 Protective Action	Alert type (watch, warning),	Two factor mixed design

			Protective action type	ANOVA
	PARQ8	Adv3 Protective Action	Alert type (watch, warning), Protective action type	Two factor mixed design ANOVA
	PARQ9	Adv4 Protective Action	Alert type (watch, warning), Protective action type	Two factor mixed design ANOVA
	PARQ10	Adv5 Protective Action	Alert type (watch, warning), Protective action type	Two factor mixed design ANOVA
	PARQ11-1	Protective Action Q5	Demographic(age, family income)	Correlation
	PARQ11-2	Protective Action Q6	Demographic(age, family income)	Correlation
	PARQ11-3	Protective Action Q7	Demographic(age, family income)	Correlation
	PARQ11-4	Protective Action Q8	Demographic(age, family income)	Correlation
	PARQ11-5	Protective Action Q9	Demographic(age, family income)	Correlation
	PARQ11-6	Protective Action Q10	Demographic(age, family income)	Correlation
	PARQ11-7	Protective Action Q11	Demographic(age, family income)	Correlation
Tornado and life experience	TELERQ1-1	4 types of experience	Adv1 risk perception, Adv1 7 types of protective action	Correlation
	TELERQ1-2	4 types of experience	Adv2 risk perception, Adv2 7 types of protective action	Correlation
	TELERQ1-2	4 types of experience	Adv2 risk perception, Adv2 7 types of protective action	Correlation
	TELERQ1-3	4 types of experience	Adv3 risk perception,	Correlation

			Adv3 7 types of protective action	
	TELERQ1-4	4 types of experience	Adv4 risk perception, Adv4 7 types of protective action	Correlation
	TELERQ1-5	4 types of experience	Adv5 risk perception, Adv5 7 types of protective action	Correlation
	TELERQ2-1	4 types of experience	Adv1 5 types of information click count, Adv1 5 types of information click duration	Correlation
	TELERQ2-2	4 types of experience	Adv2 5 types of information click count, Adv2 5 types of information click duration	Correlation
	TELERQ2-3	4 types of experience	Adv3 5 types of information click count, Adv3 5 types of information click duration	Correlation
	TELERQ2-4	4 types of experience	Adv4 5 types of information click count, Adv4 5 types of information click duration	Correlation
	TELERQ2-5	4 types of experience	Adv5 5 types of information click count, Adv1 5 types of information click duration	Correlation

APPENDIX D: Group A Watch Scenario (Information Type 1)

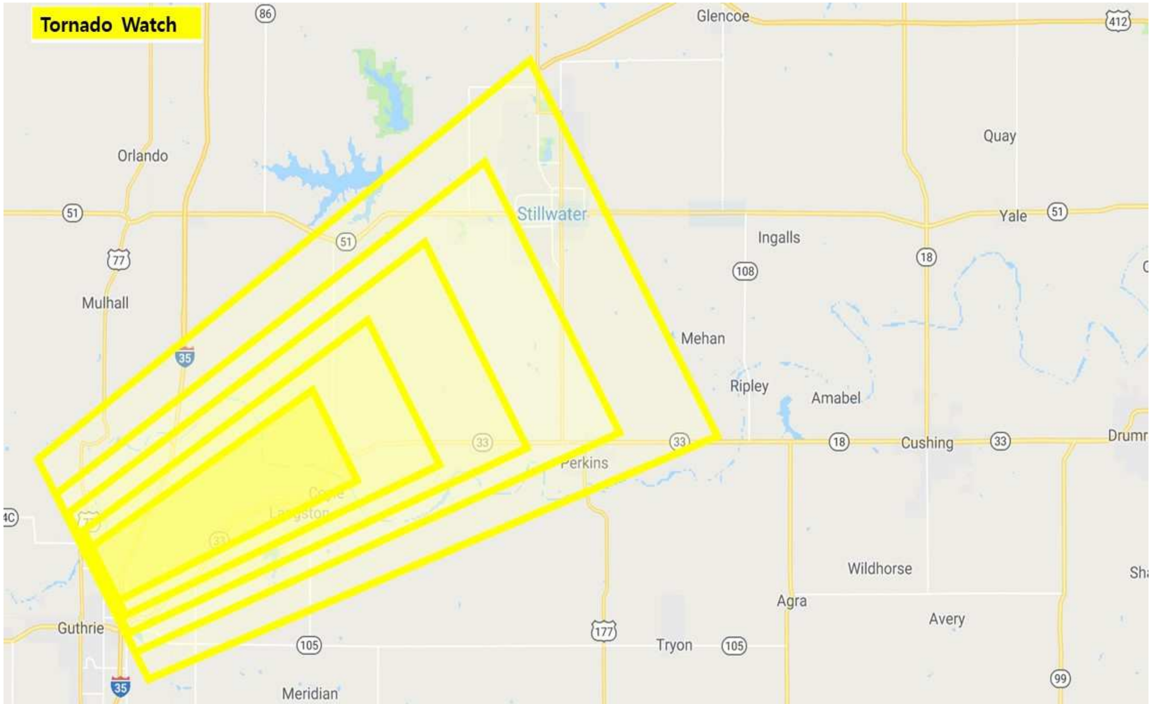
Student Group A (N=159)



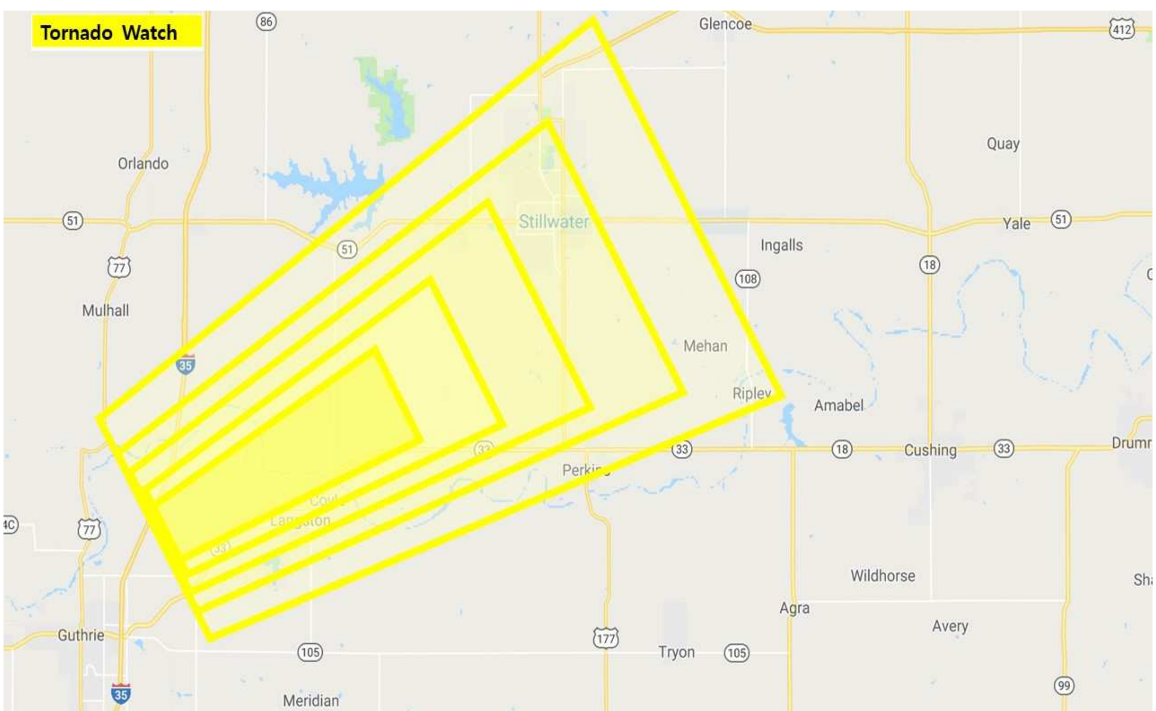
Yellow gradient polygon only (Information type1)

Advisory 1	Advisory 2 (2:10 pm)	Advisory 3 (2:20 pm)	Advisory 4 (2:30 pm)	Advisory 5 (2:40 pm)

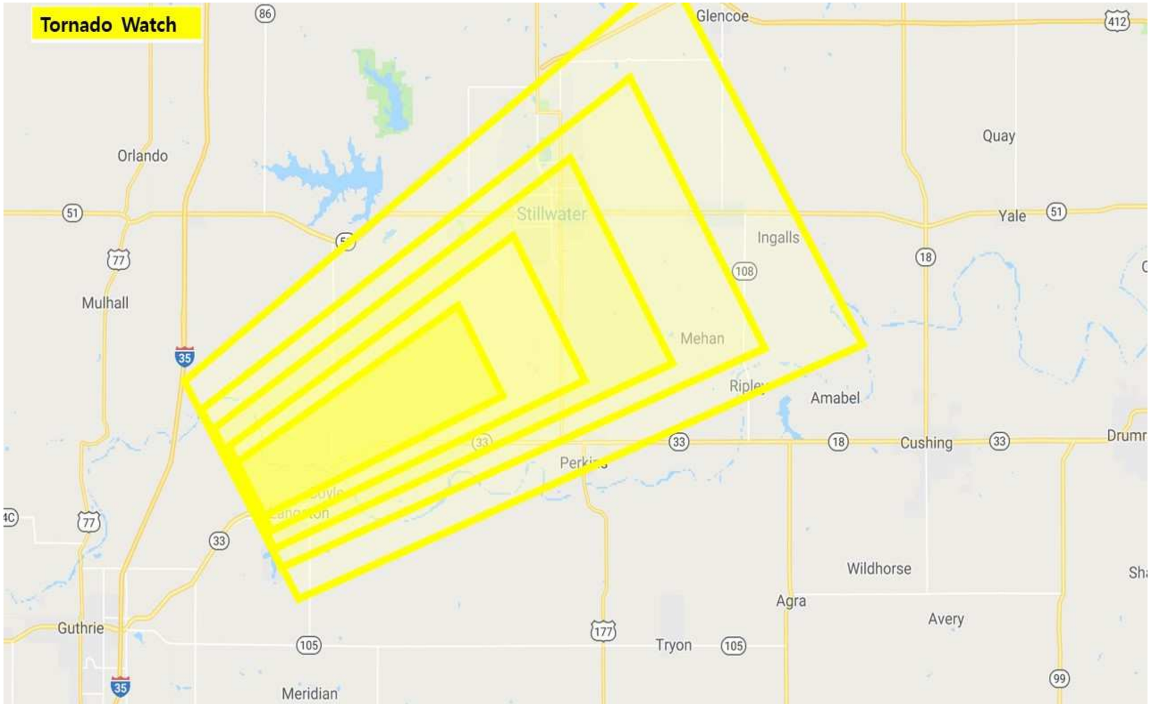
Advisory 1 (It is 2:00 PM, on March 3, 2020)



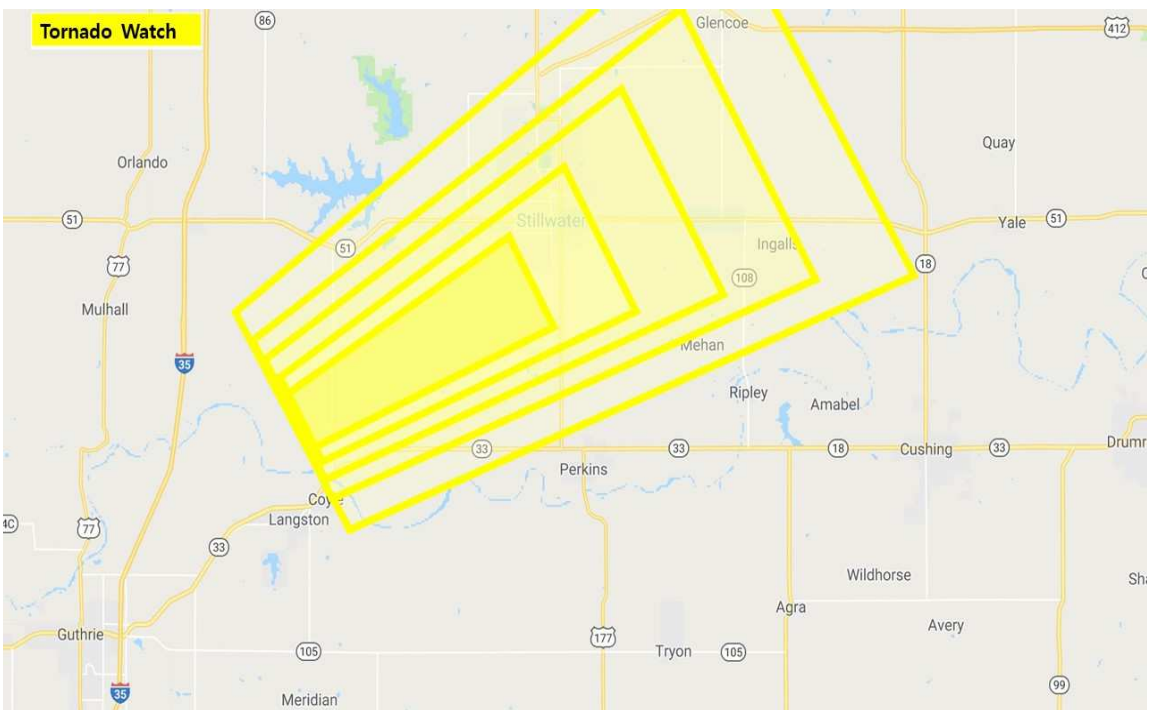
Advisory 2 (10 minutes has passed. It is 2:10 PM, on March 3, 2020)



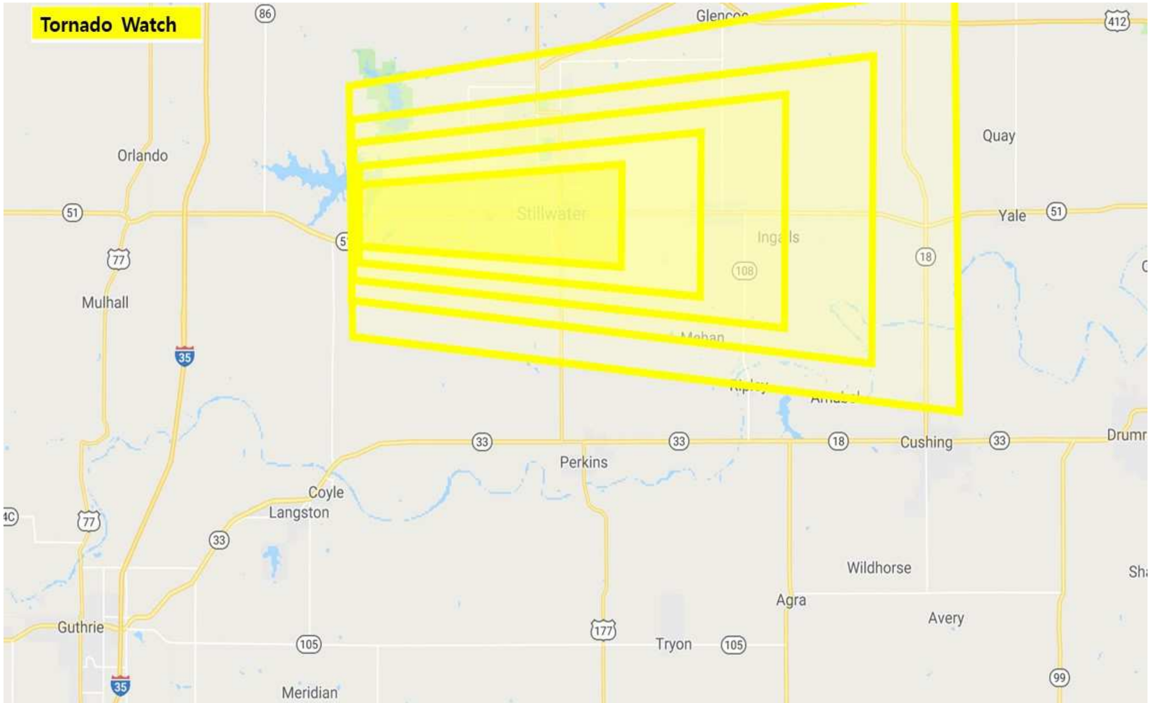
Advisory 3 (Another 10 minutes has passed. It is 2:20 PM, on March 3, 2020)



Advisory 4 (Another 10 minutes has passed. It is 2:30 PM, on March 3, 2020)

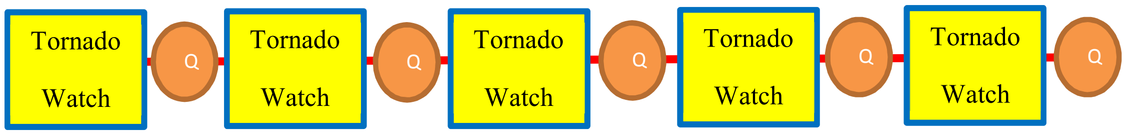


Advisory 5 (Another 10 minutes has passed. It is 2:40 PM, on March 3, 2020)

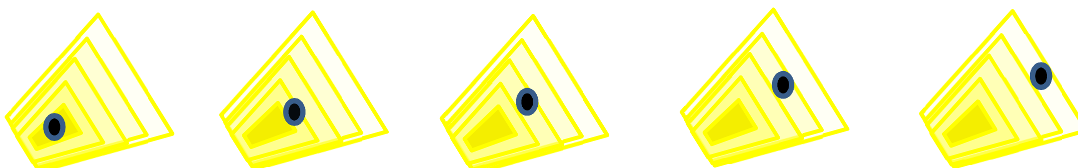


APPENDIX D: Group A Watch Scenario (Information Type 2)

Student Group A (N=159)

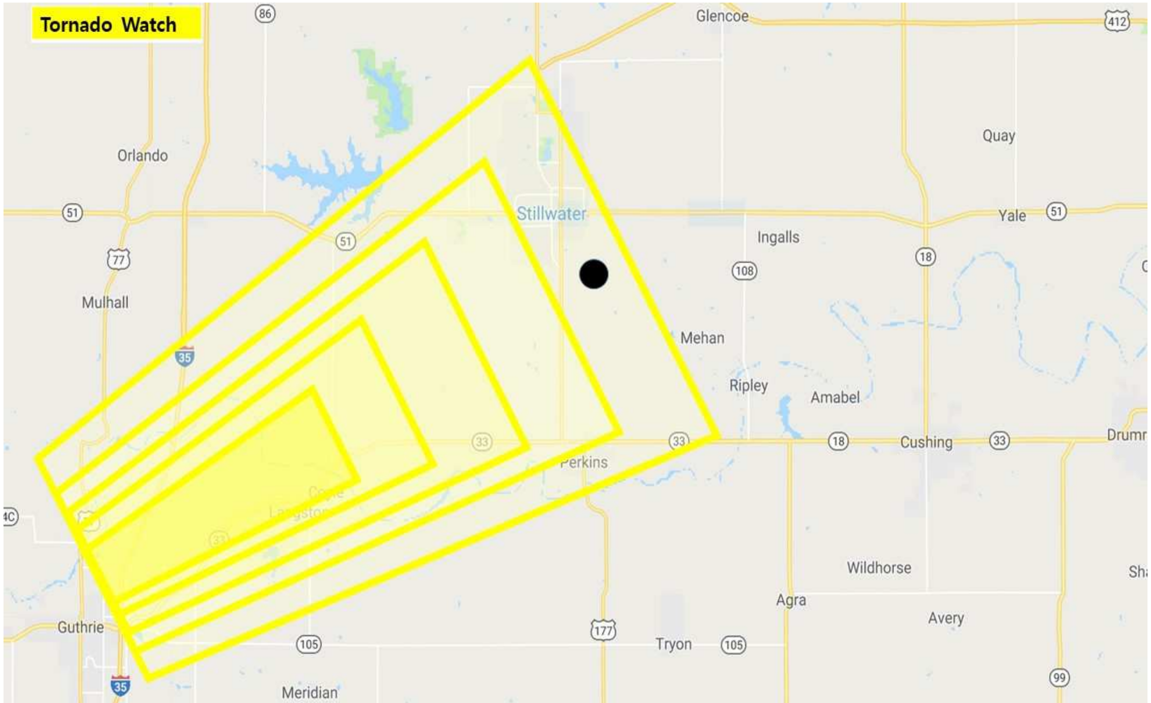


Yellow gradient polygon plus location (Information Type 2)

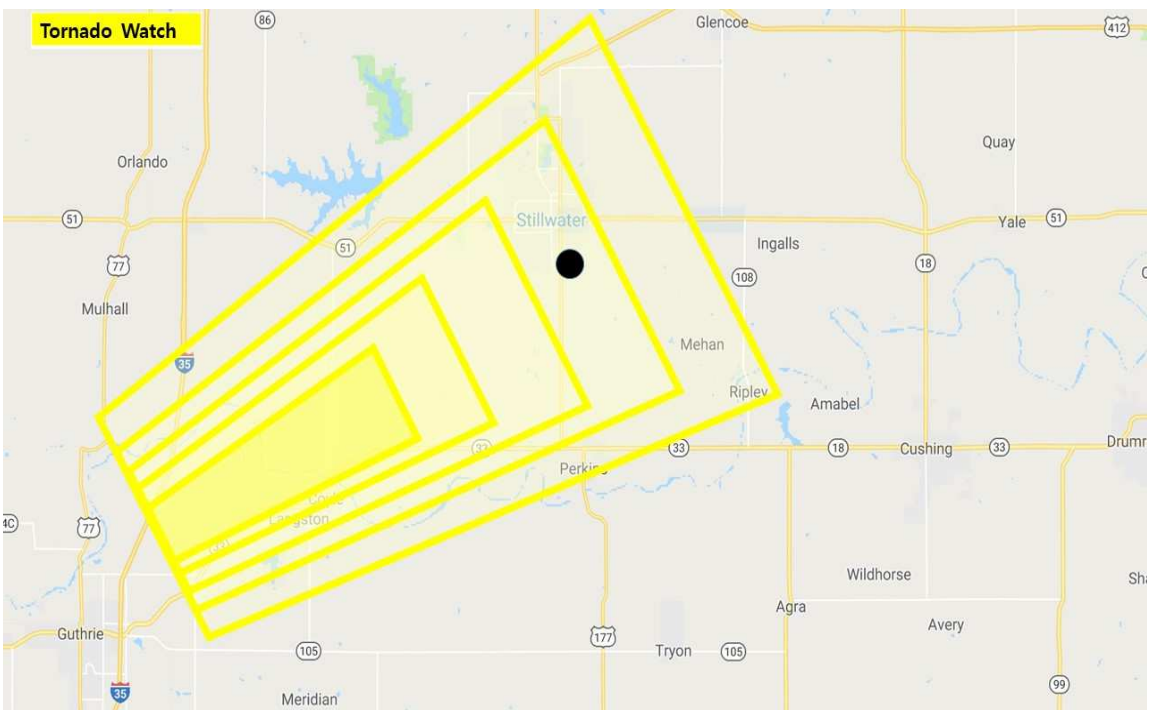


Advisory 1	Advisory 2	Advisory 3	Advisory 4	Advisory 5
(2:00 pm)	(2:10 pm)	(2:20 pm)	(2:30 pm)	(2:40 pm)

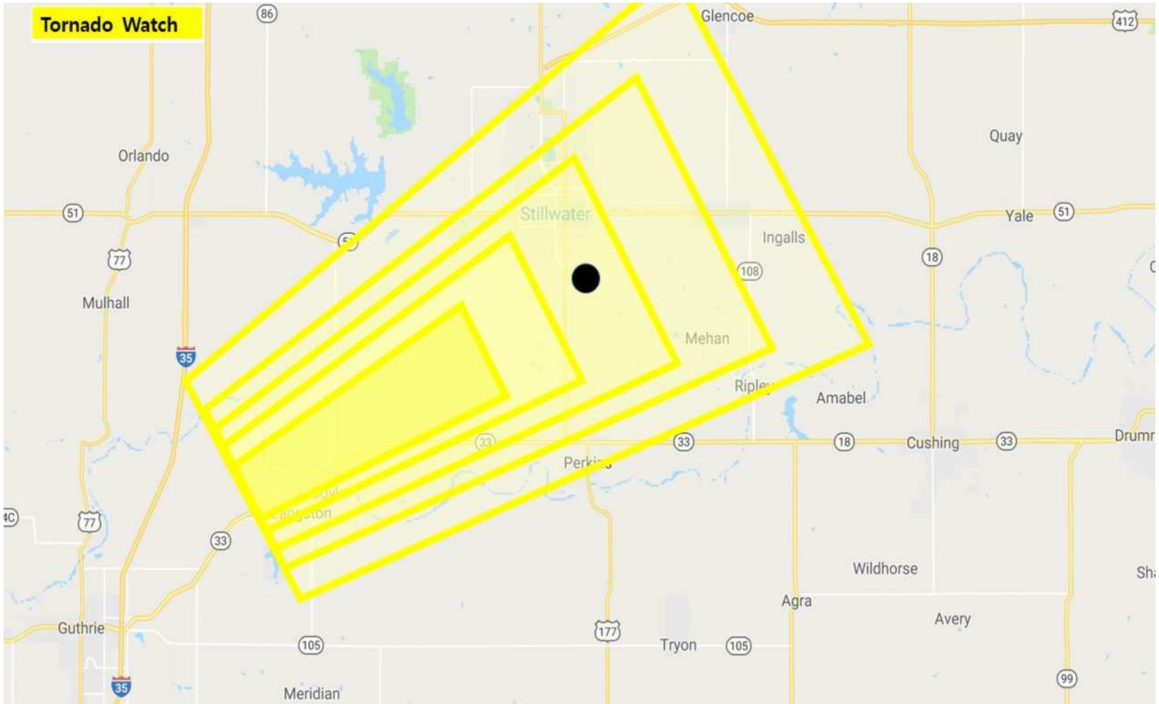
Advisory 1 (It is 2:00 PM, on March 3, 2020)



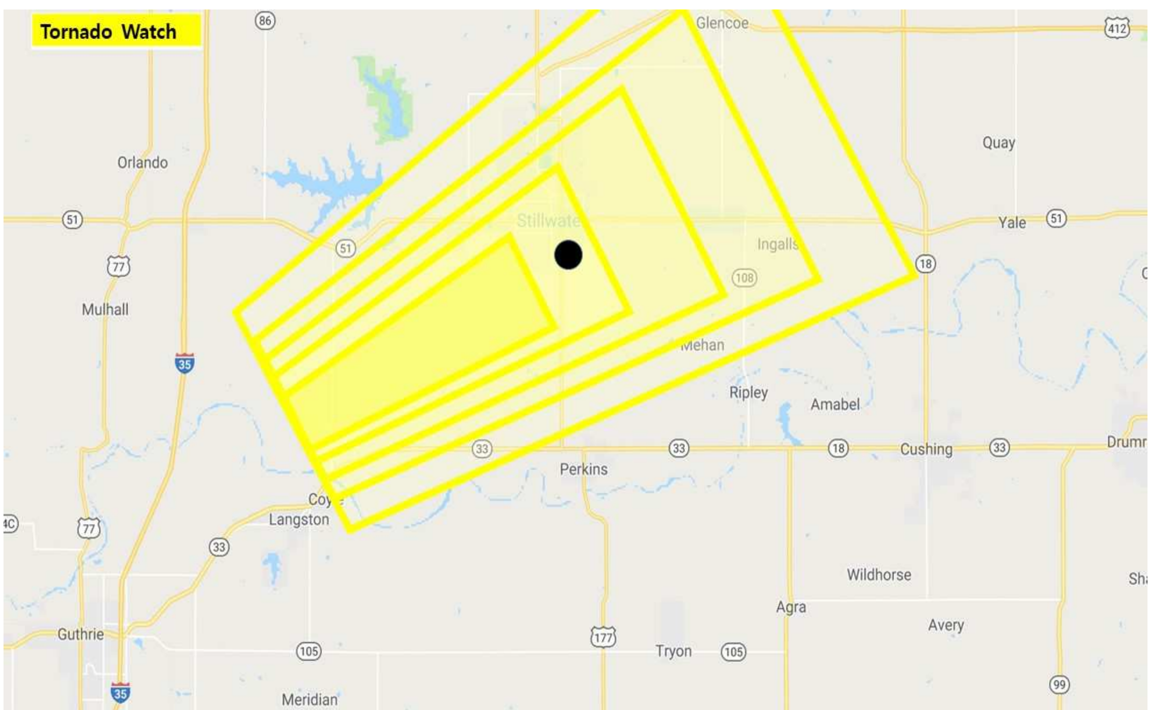
Advisory 2 (10 minutes has passed. It is 2:10 PM, on March 3, 2020)



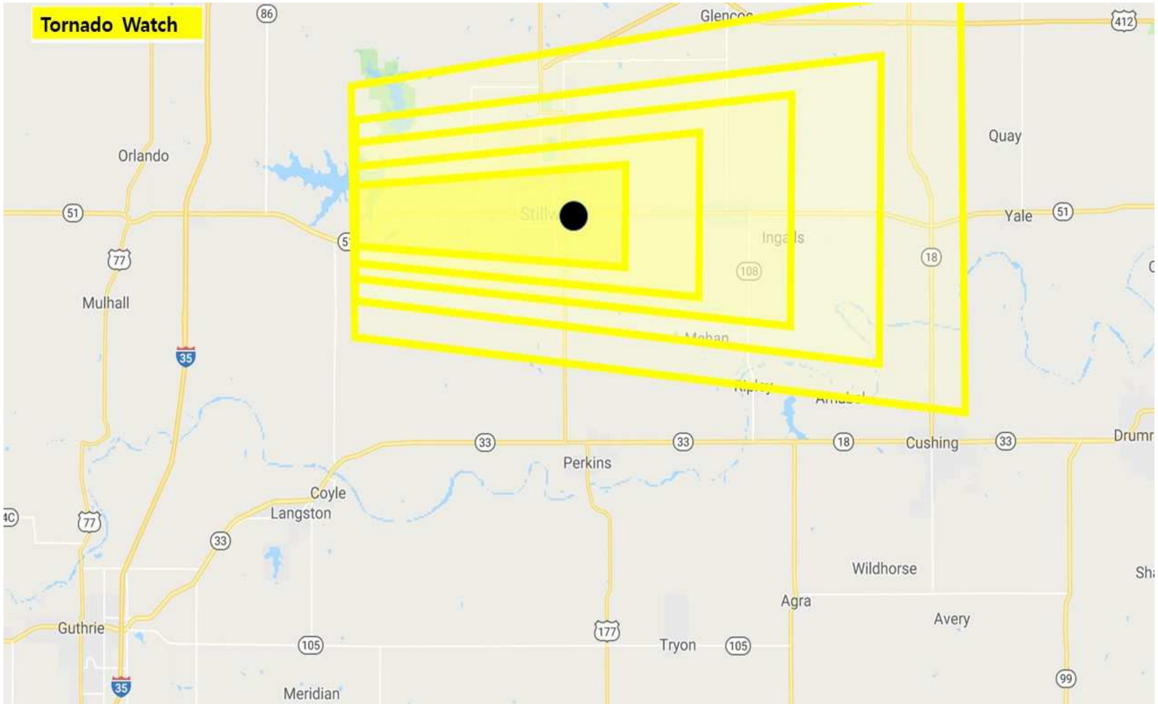
Advisory 3 (Another 10 minutes has passed. It is 2:20 PM, on March 3, 2020)



Advisory 4 (Another 10 minutes has passed. It is 2:30 PM, on March 3, 2020)

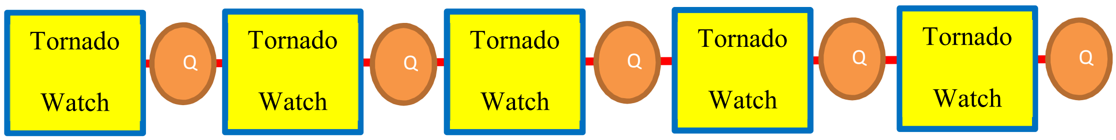


Advisory 5 (Another 10 minutes has passed. It is 2:40 PM, on March 3, 2020)

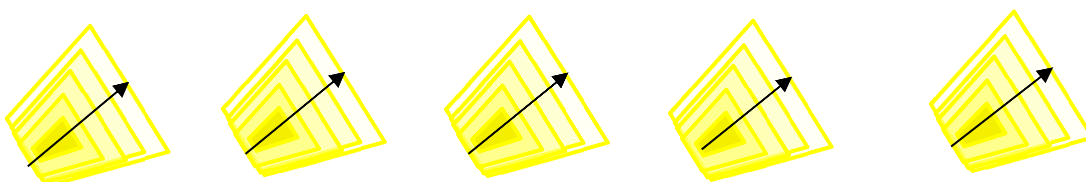


APPENDIX D: Group A Watch Scenario (Information Type 3)

Student Group A (N=159)

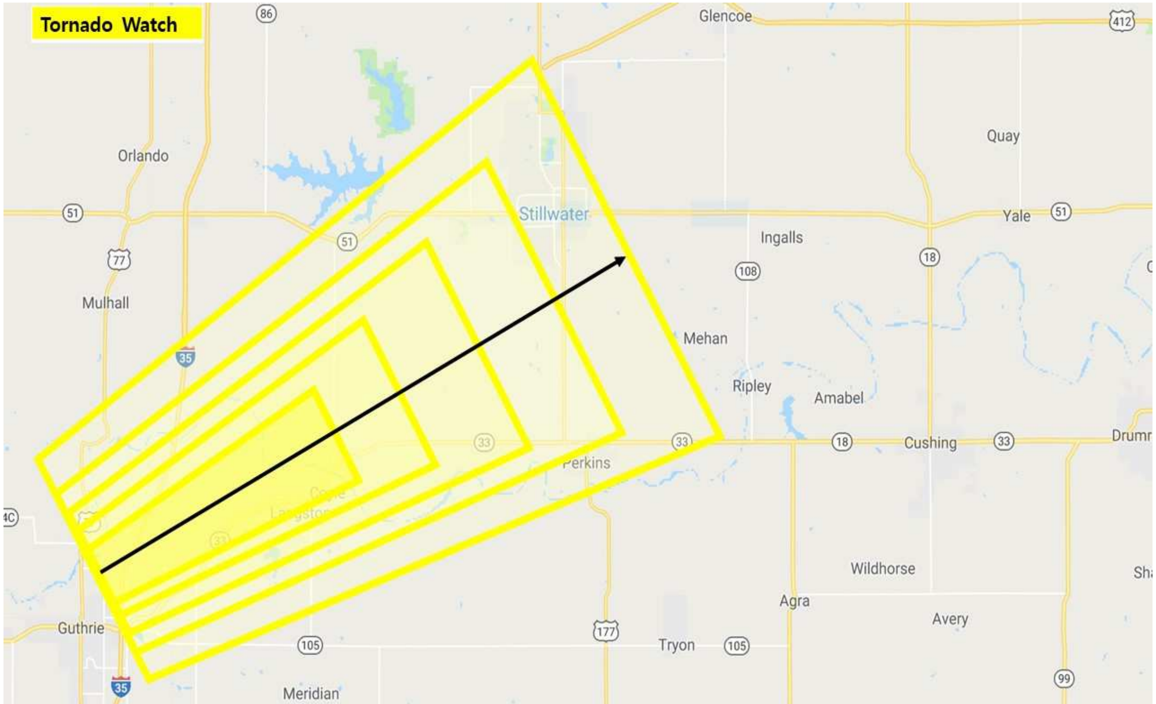


Yellow gradient polygon plus track-line (Information Type 3)

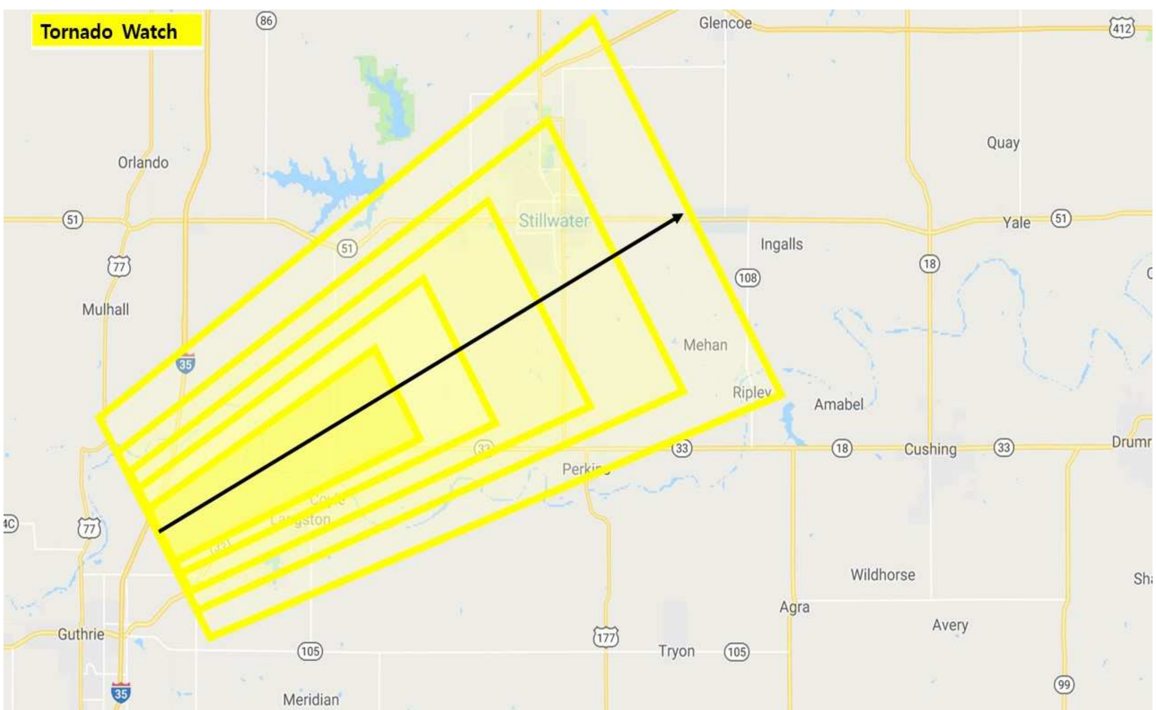


Advisory 1 (2:00 pm) | Advisory 2 (2:10 pm) | Advisory 3 (2:20 pm) | Advisory 4 (2:30 pm) | Advisory 5 (2:40 pm)

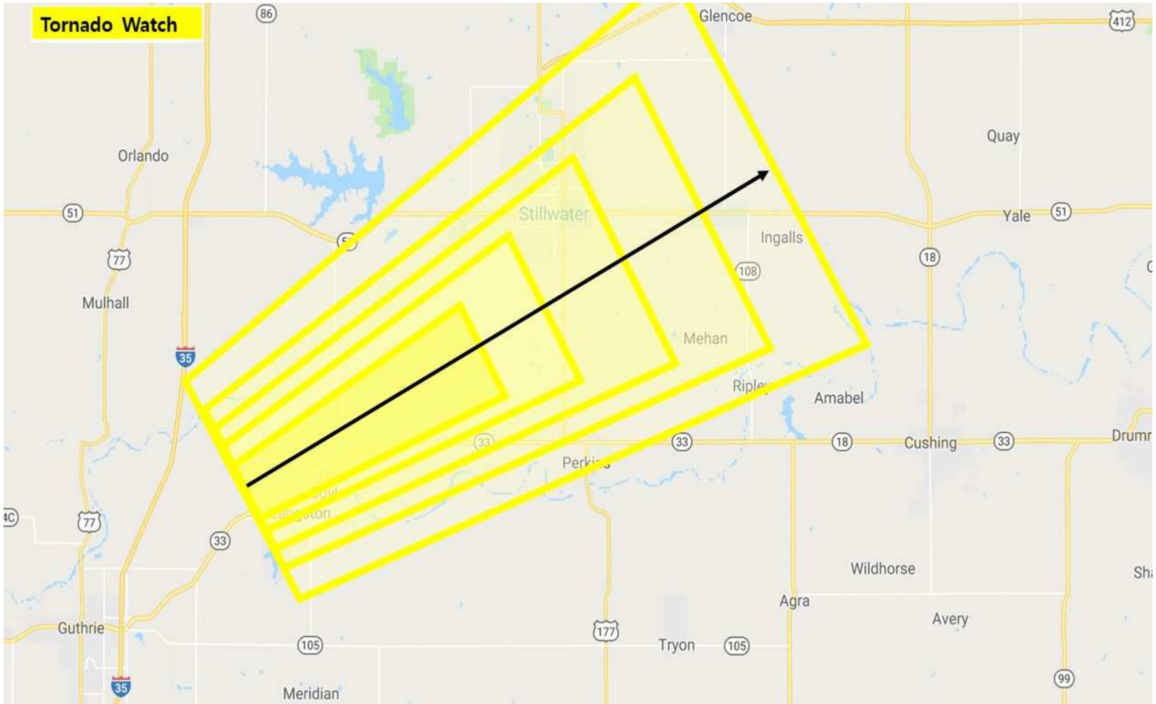
Advisory 1 (It is 2:00 PM, on March 3, 2020)



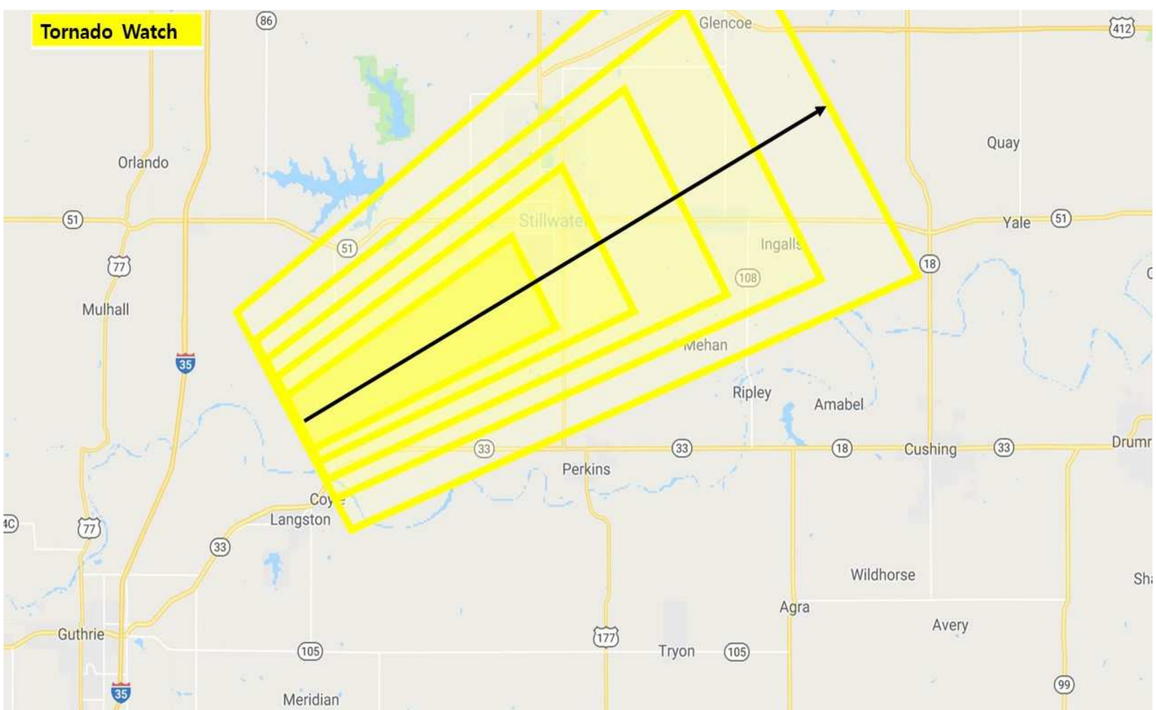
Advisory 2 (10 minutes has passed. It is 2:10 PM, on March 3, 2020)



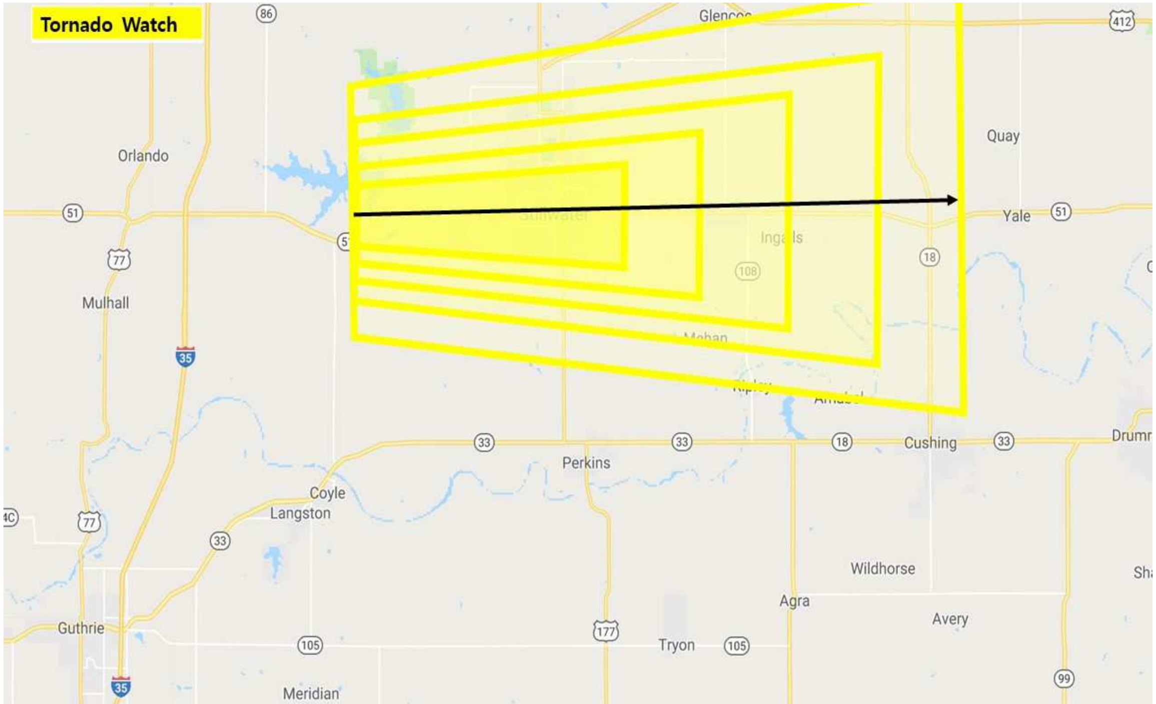
Advisory 3 (Another 10 minutes has passed. It is 2:20 PM, on March 3, 2020)



Advisory 4 (Another 10 minutes has passed. It is 2:30 PM, on March 3, 2020)

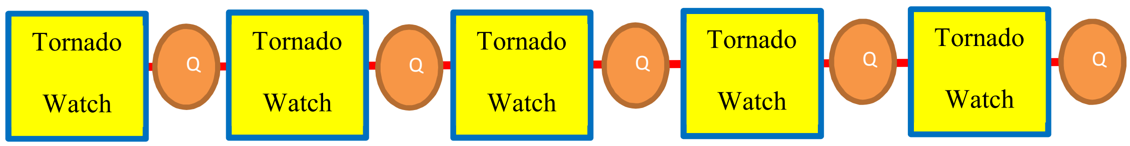


Advisory 5 (Another 10 minutes has passed. It is 2:40 PM, on March 3, 2020)

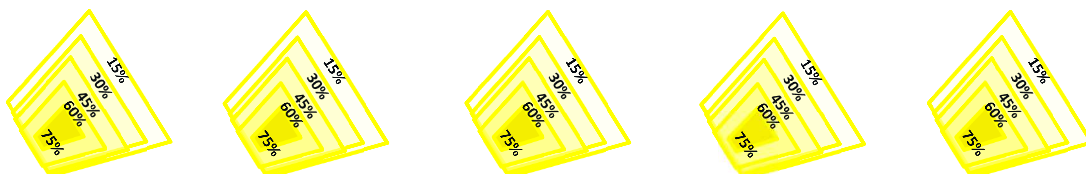


APPENDIX D: Group A Watch Scenario (Information Type 4)

Student Group A (N=50)

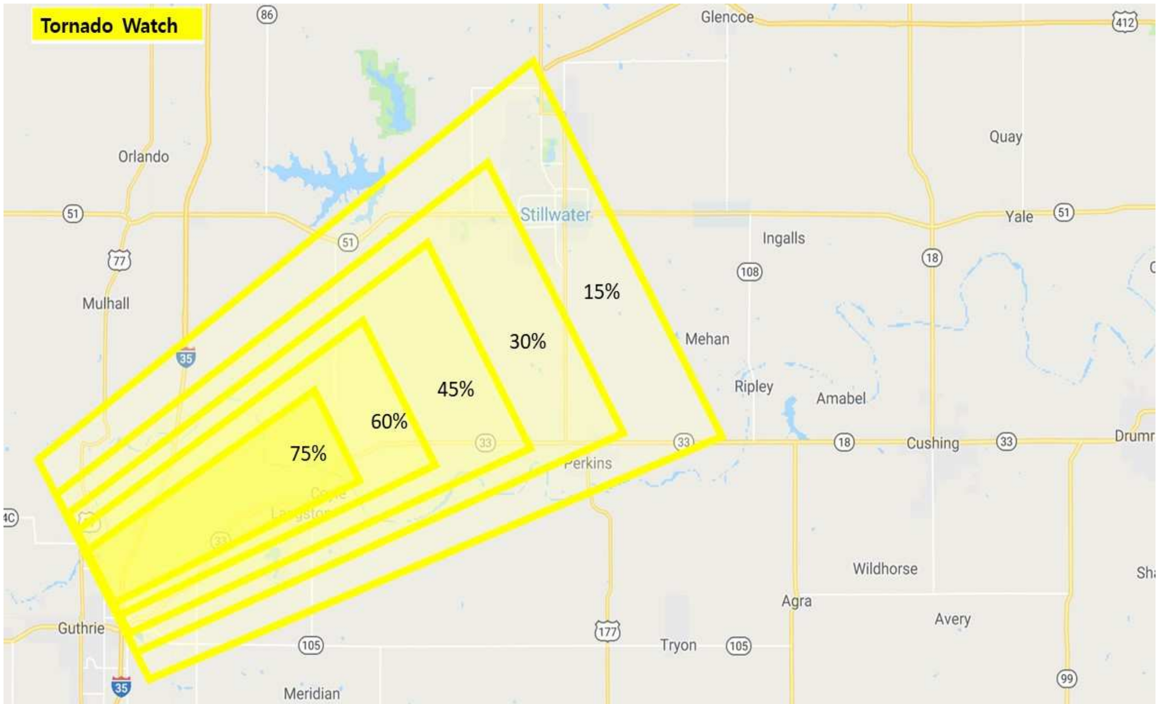


Yellow gradient polygon plus tornado strike probability (Information Type 4)

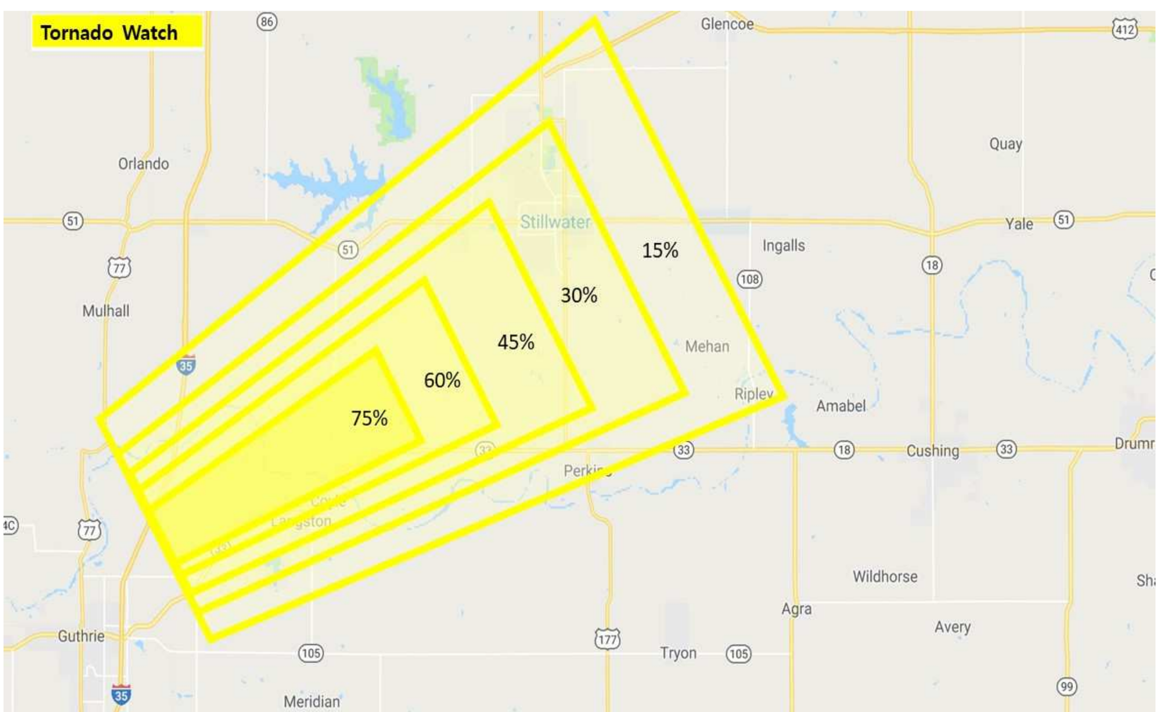


Advisory 1 (2:00 pm) | Advisory 2 (2:10 pm) | Advisory 3 (2:20 pm) | Advisory 4 (2:30 pm) | Advisory 5 (2:40 pm)

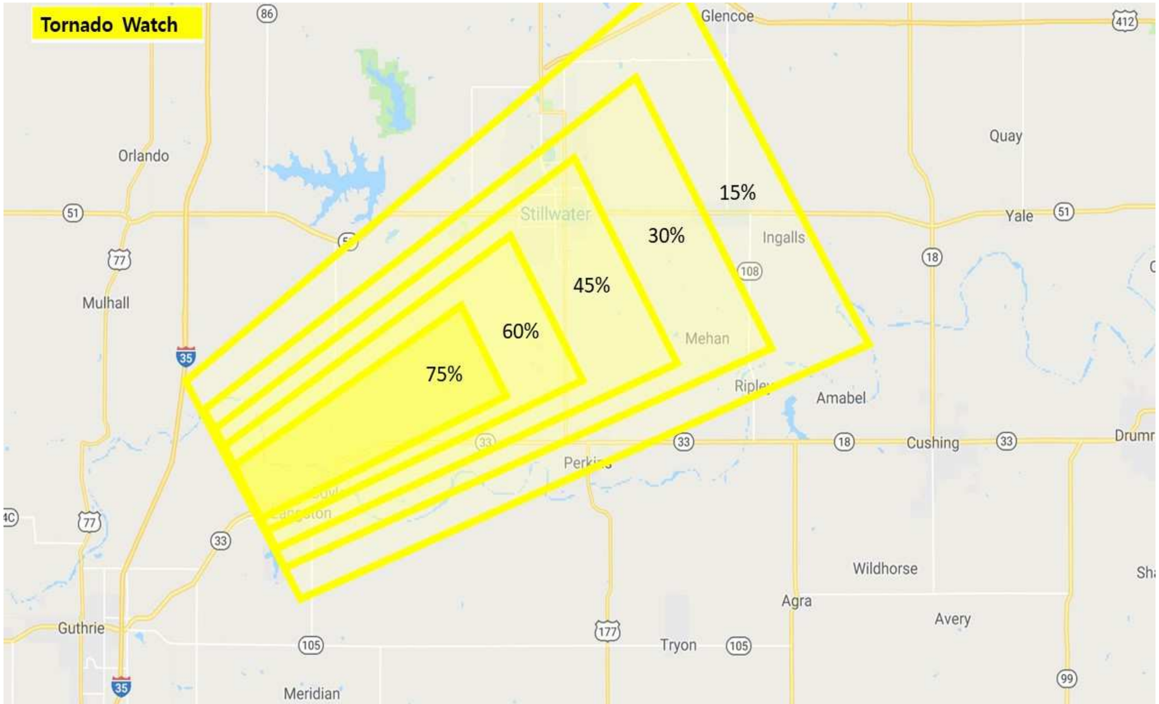
Advisory 1 (It is 2:00 PM, on March 3, 2020)



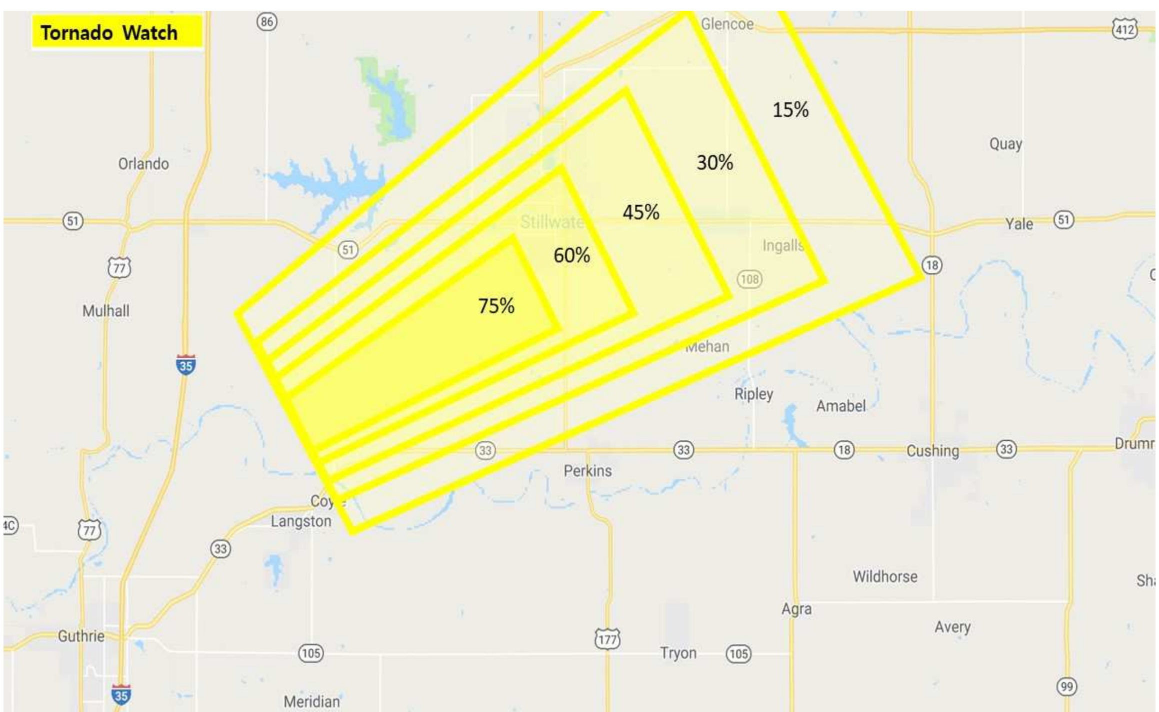
Advisory 2 (10 minutes has passed. It is 2:10 PM, on March 3, 2020)



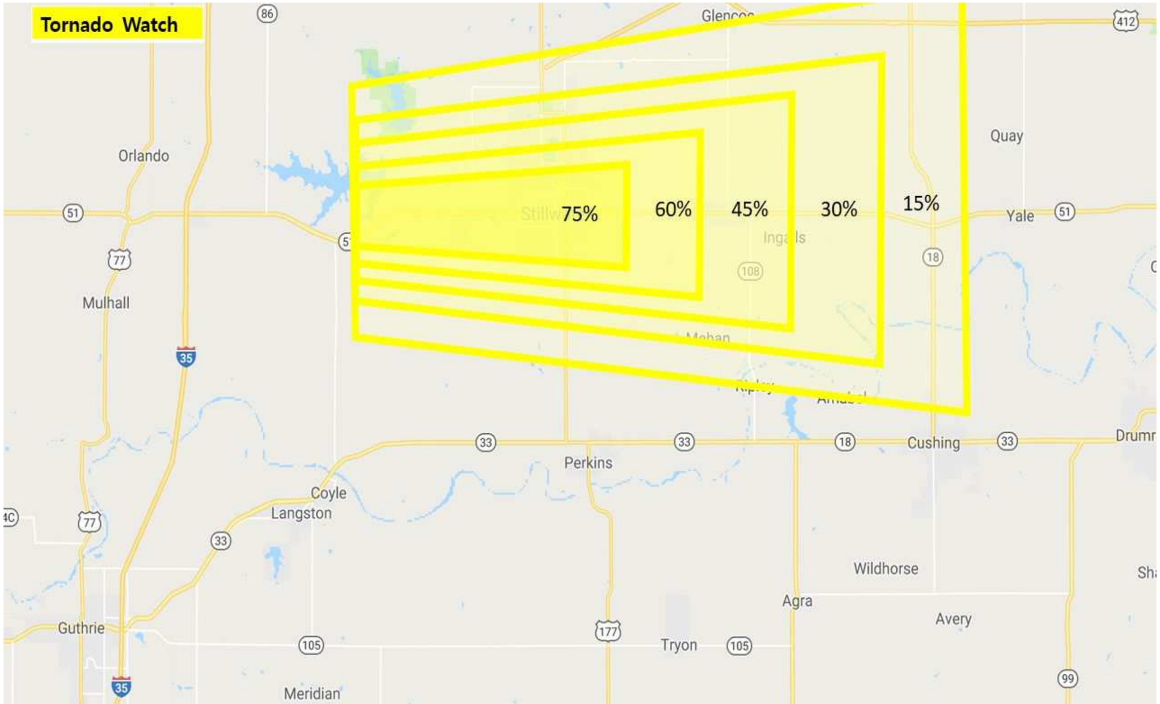
Advisory 3 (Another 10 minutes has passed. It is 2:20 PM, on March 3, 2020)



Advisory 4 (Another 10 minutes has passed. It is 2:30 PM, on March 3, 2020)

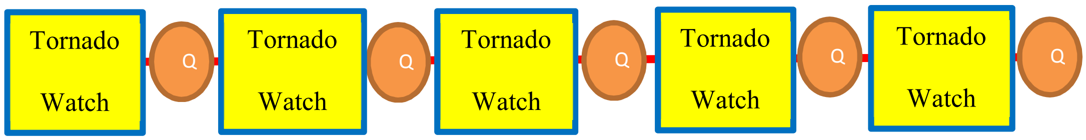


Advisory 5 (Another 10 minutes has passed. It is 2:40 PM, on March 3, 2020)

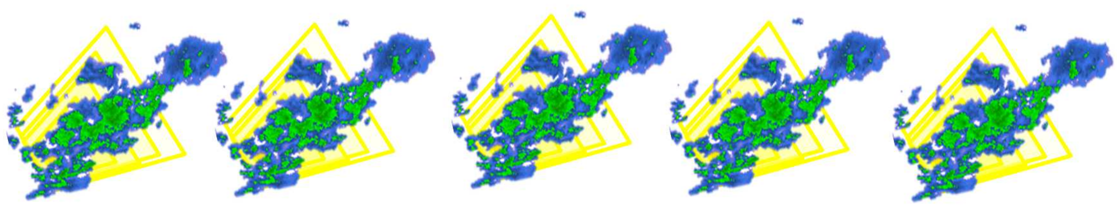


APPENDIX D: Group A Watch Scenario (Information Type 5)

Student Group A (N=159)

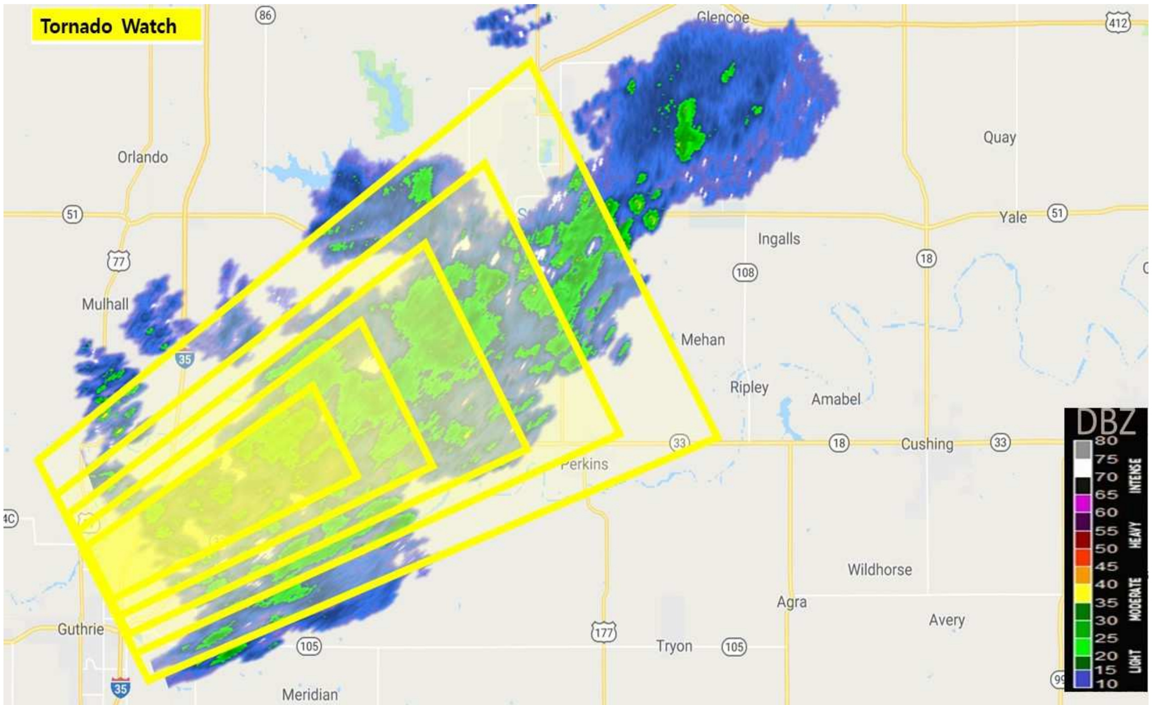


Yellow gradient polygon plus radar image (Information Type 5)

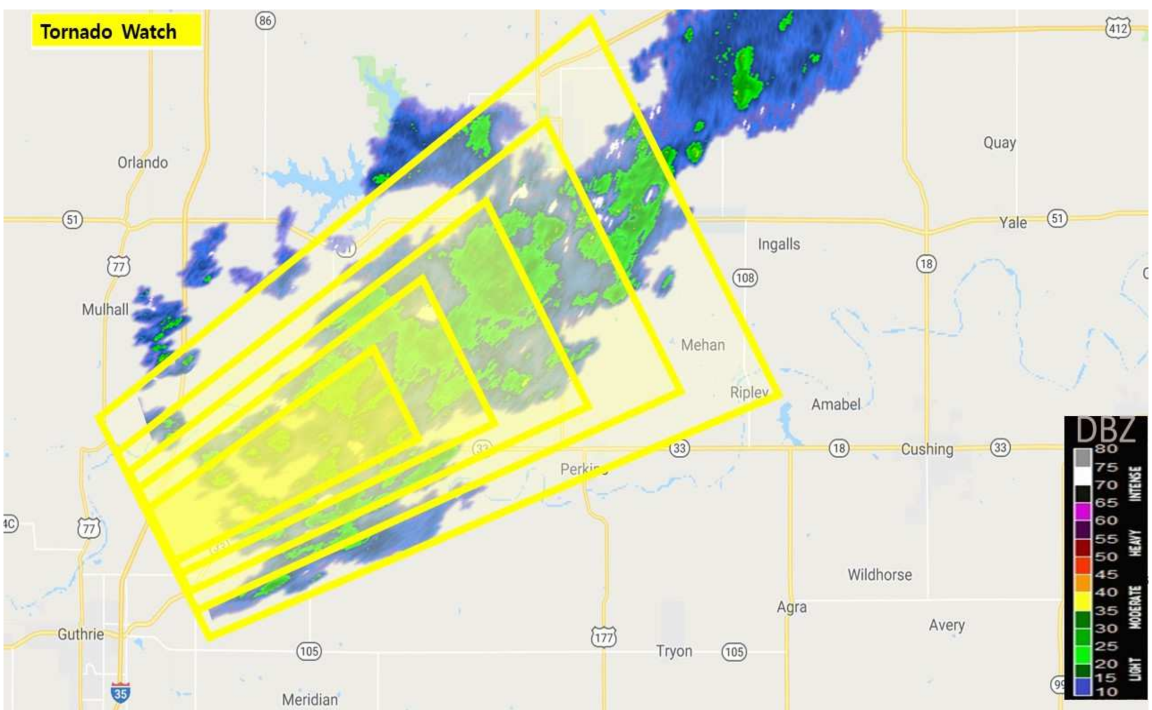


Advisory 1 (2:00 pm) | Advisory 2 (2:10 pm) | Advisory 3 (2:20 pm) | Advisory 4 (2:30 pm) | Advisory 5 (2:40 pm)

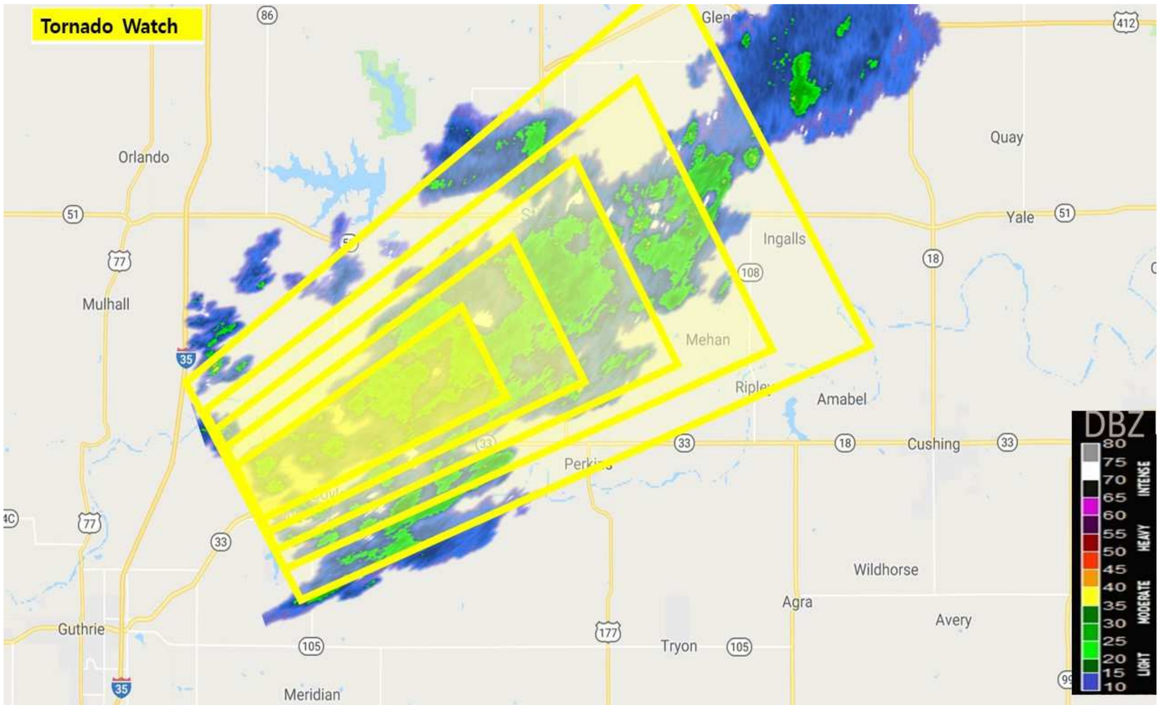
Advisory 1 (It is 2:00 PM, on March 3, 2020)



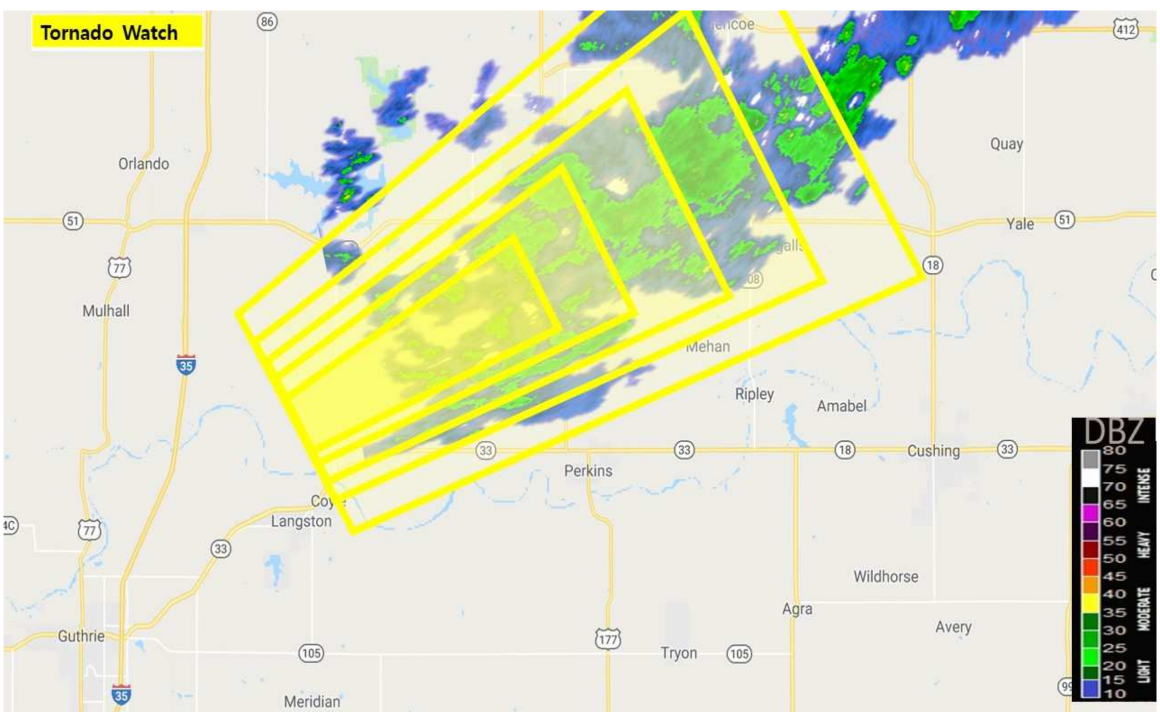
Advisory 2 (10 minutes has passed. It is 2:10 PM, on March 3, 2020)



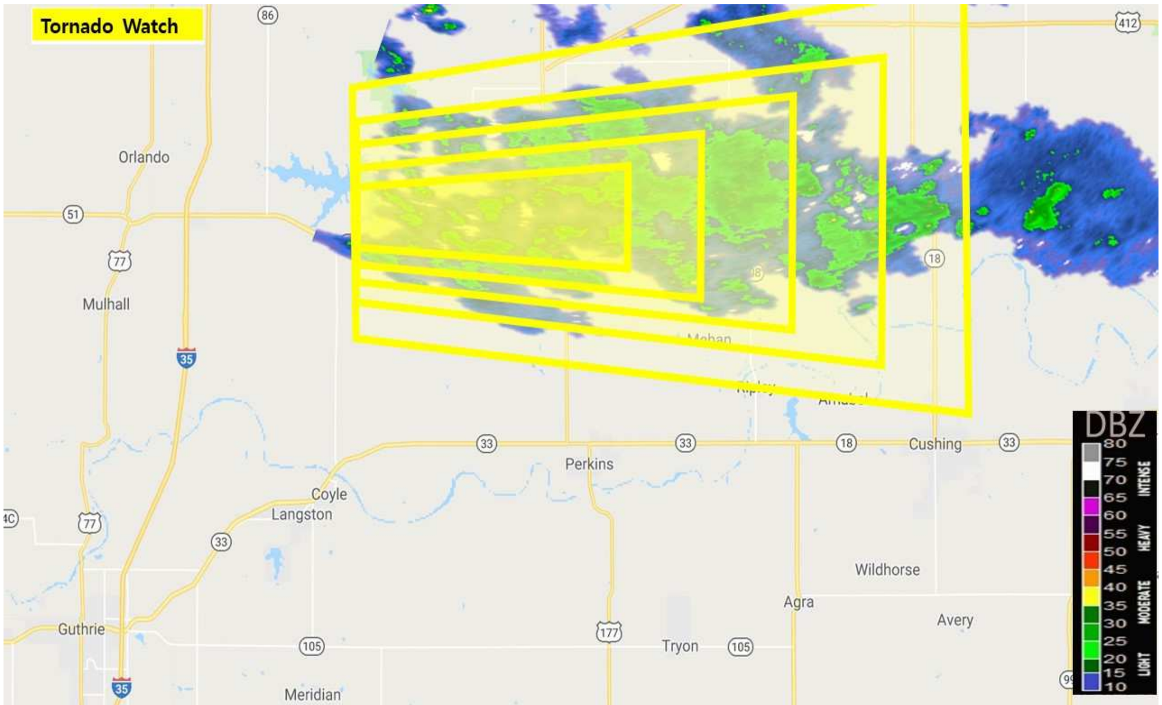
Advisory 3 (Another 10 minutes has passed. It is 2:20 PM, on March 3, 2020)



Advisory 4 (Another 10 minutes has passed. It is 2:30 PM, on March 3, 2020)

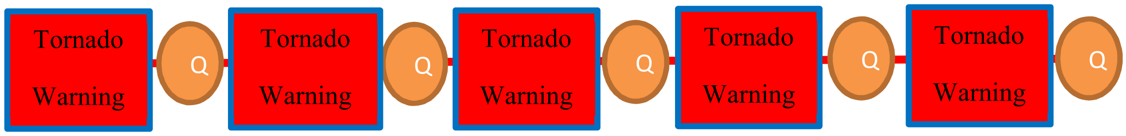


Advisory 5 (Another 10 minutes has passed. It is 2:40 PM, on March 3, 2020)

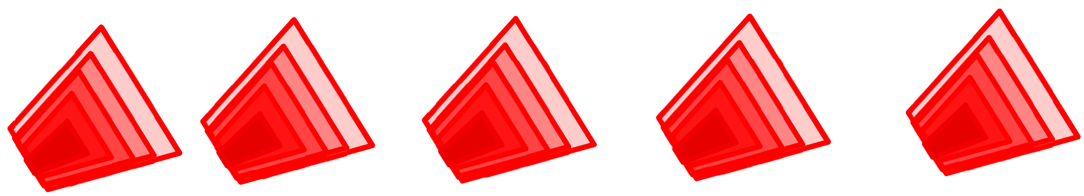


APPENDIX E: Group B Warning Scenario (Information Type 1)

Student Group B (N=139)

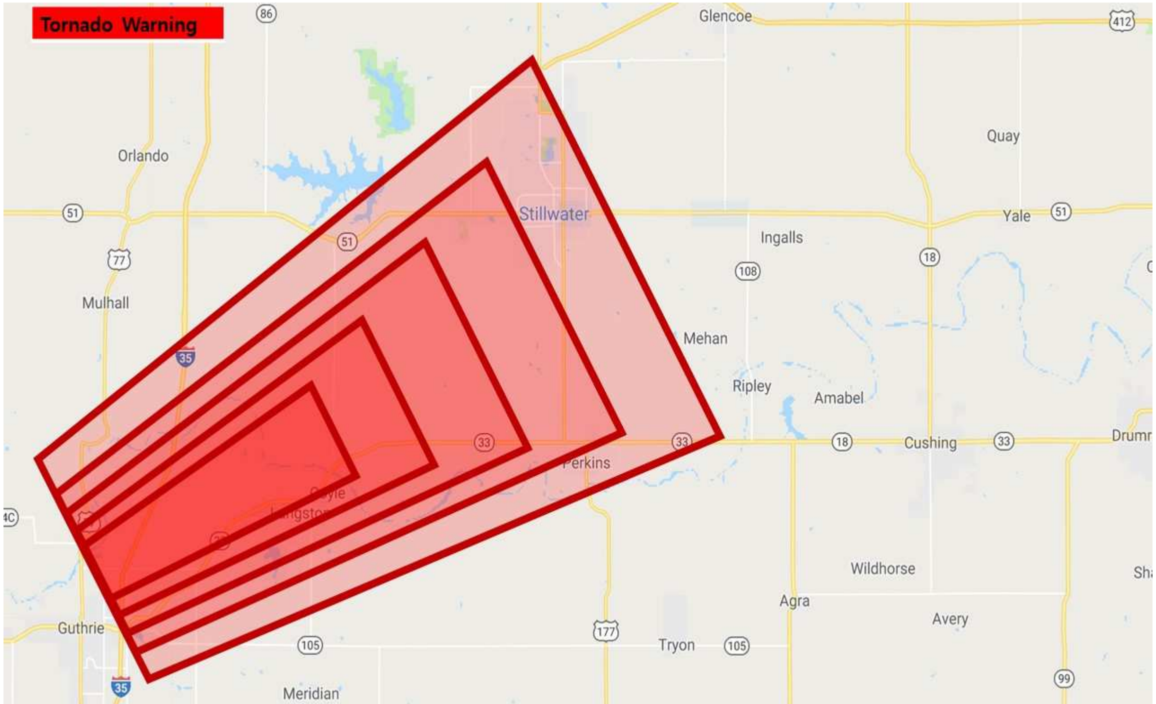


Red gradient polygon (Information Type 1)

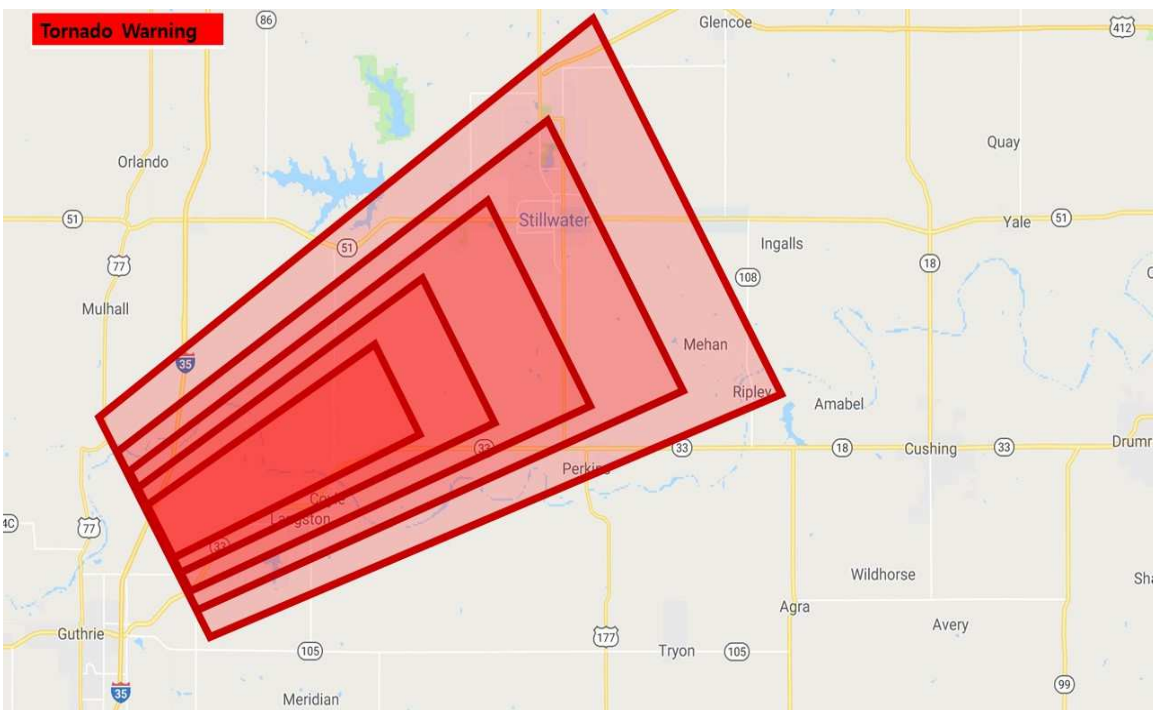


Advisory 1	Advisory 2	Advisory 3	Advisory 4	Advisory 5
(2:00 pm)	(2:10 pm)	(2:20 pm)	(2:30 pm)	(2:40 pm)

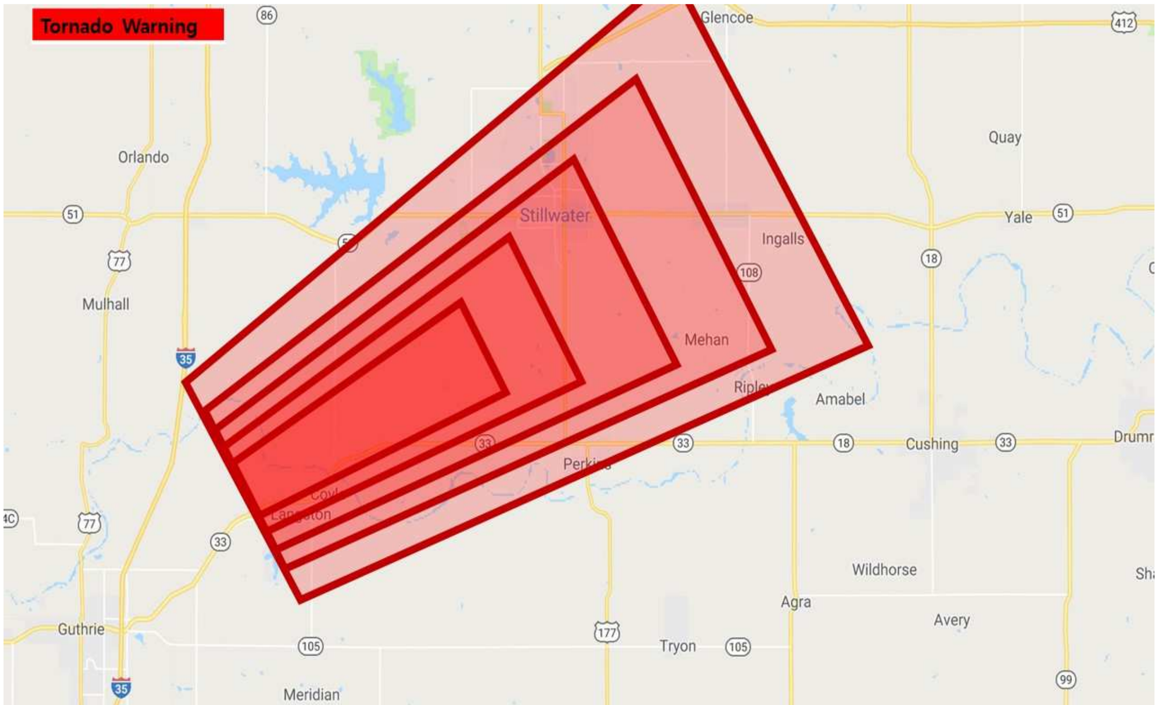
Advisory 1 (It is 2:00 PM, on March 3, 2020)



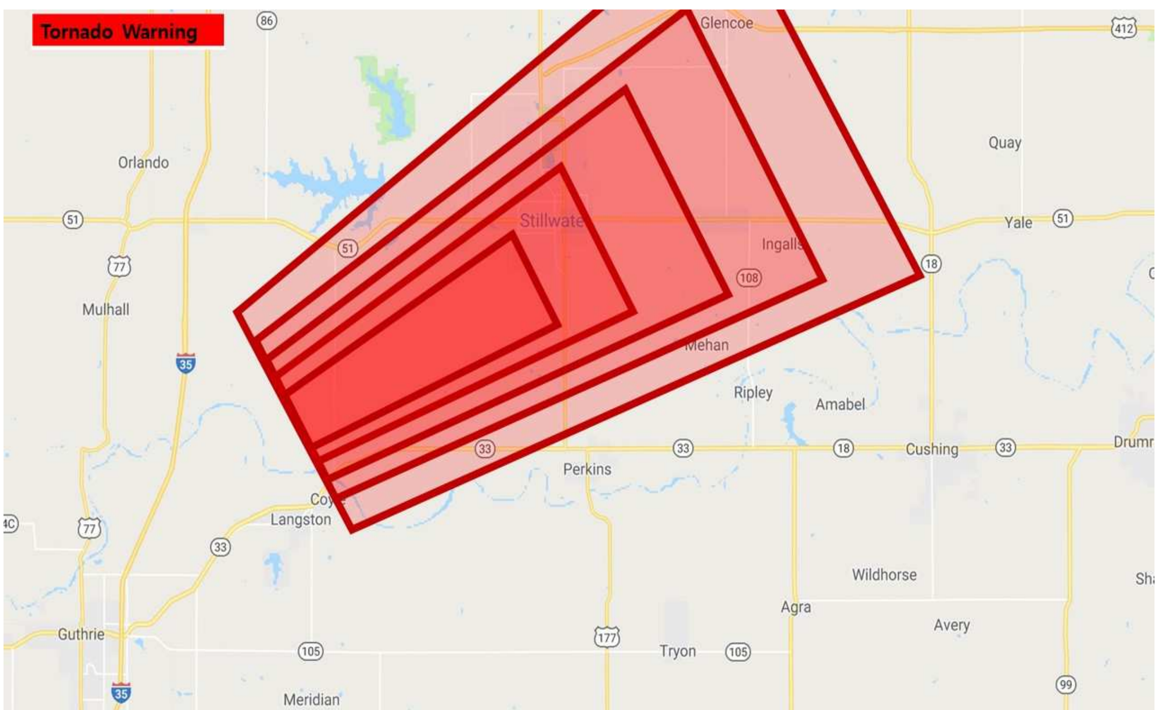
Advisory 2 (10 minutes has passed. It is 2:10 PM, on March 3, 2020)



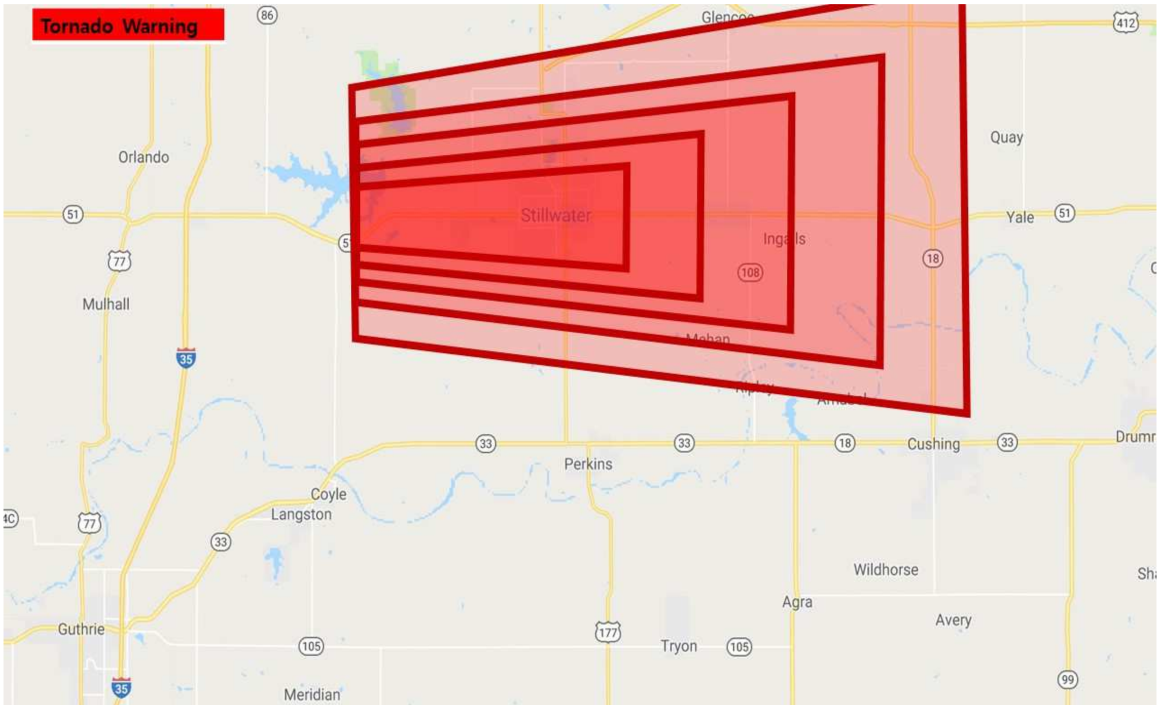
Advisory 3 (Another 10 minutes has passed. It is 2:20 PM, on March 3, 2020)



Advisory 4 (Another 10 minutes has passed. It is 2:30 PM, on March 3, 2020)

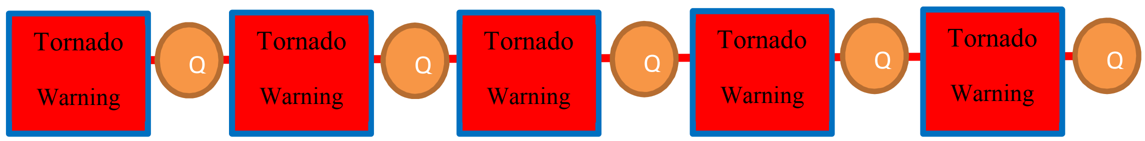


Advisory 5 (Another 10 minutes has passed. It is 2:40 PM, on March 3, 2020)

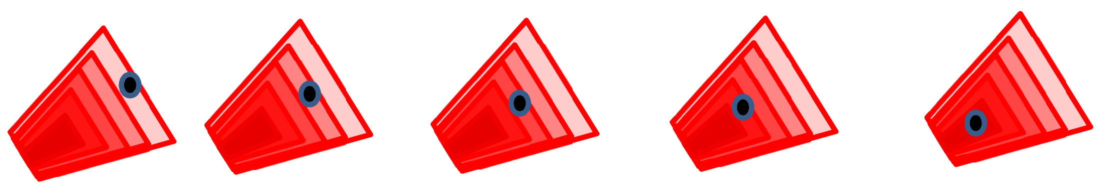


APPENDIX E: Group B Warning Scenario (Information Type 2)

Student Group A (N=139)

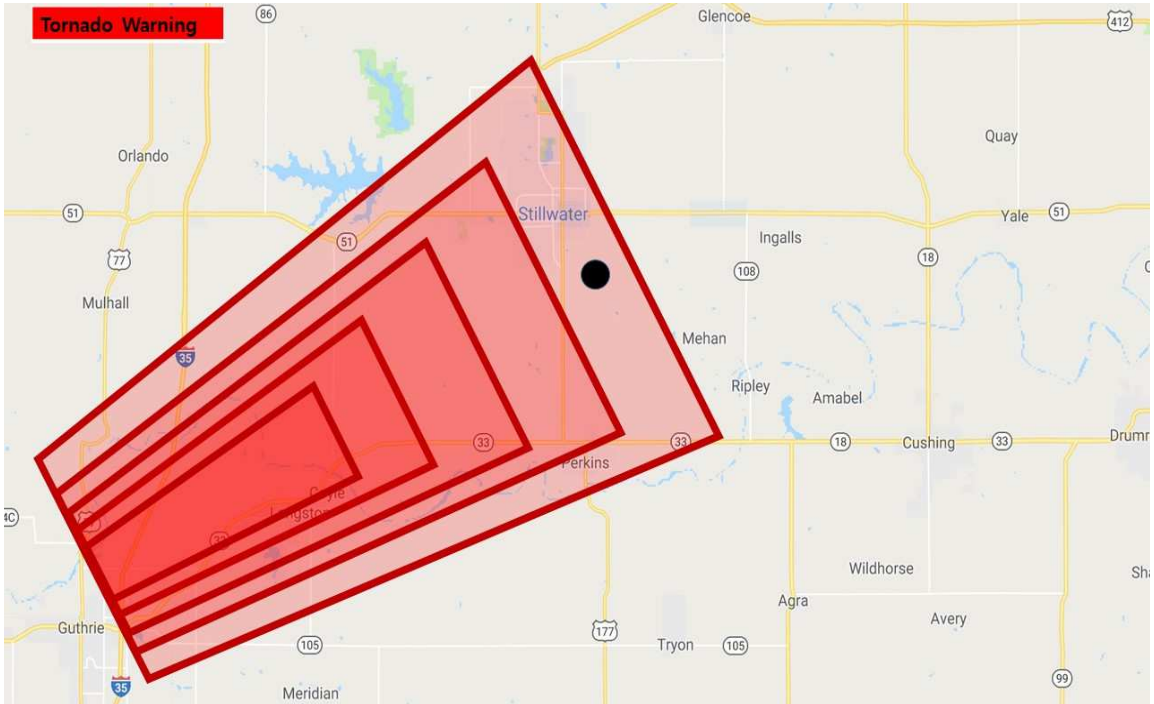


Red gradient polygon plus location (Information Type 2)

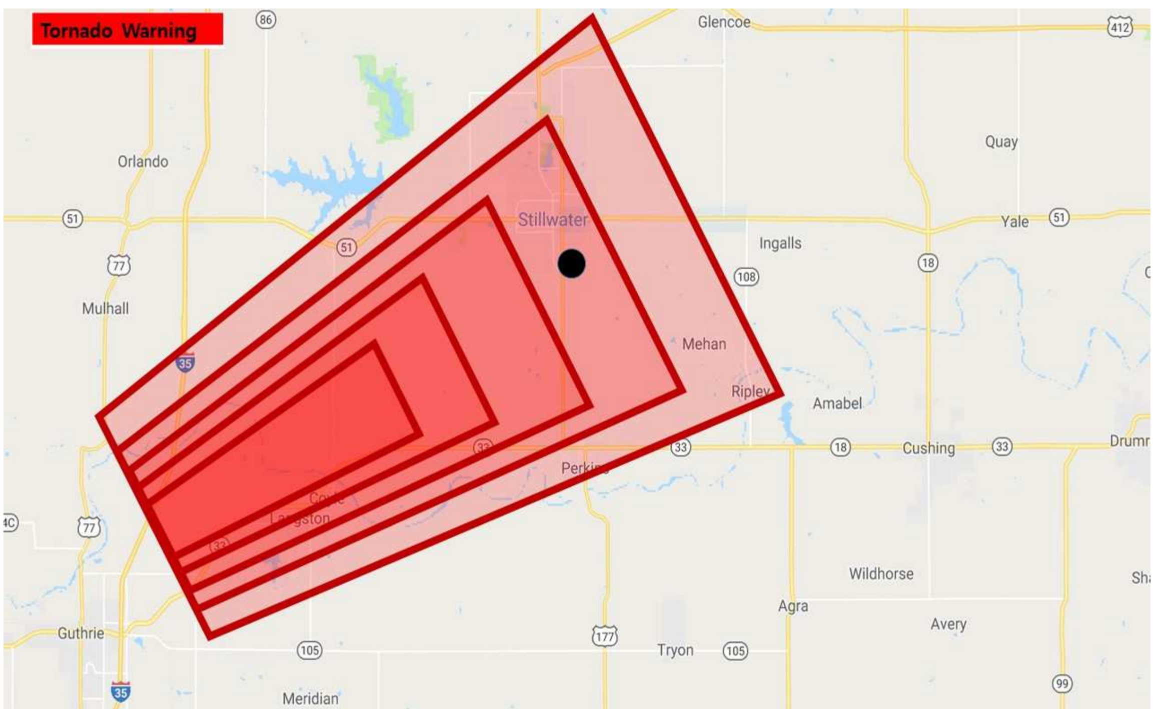


Advisory 1 (2:00 pm) | Advisory 2 (2:10 pm) | Advisory 3 (2:20 pm) | Advisory 4 (2:30 pm) | Advisory 5 (2:40 pm)

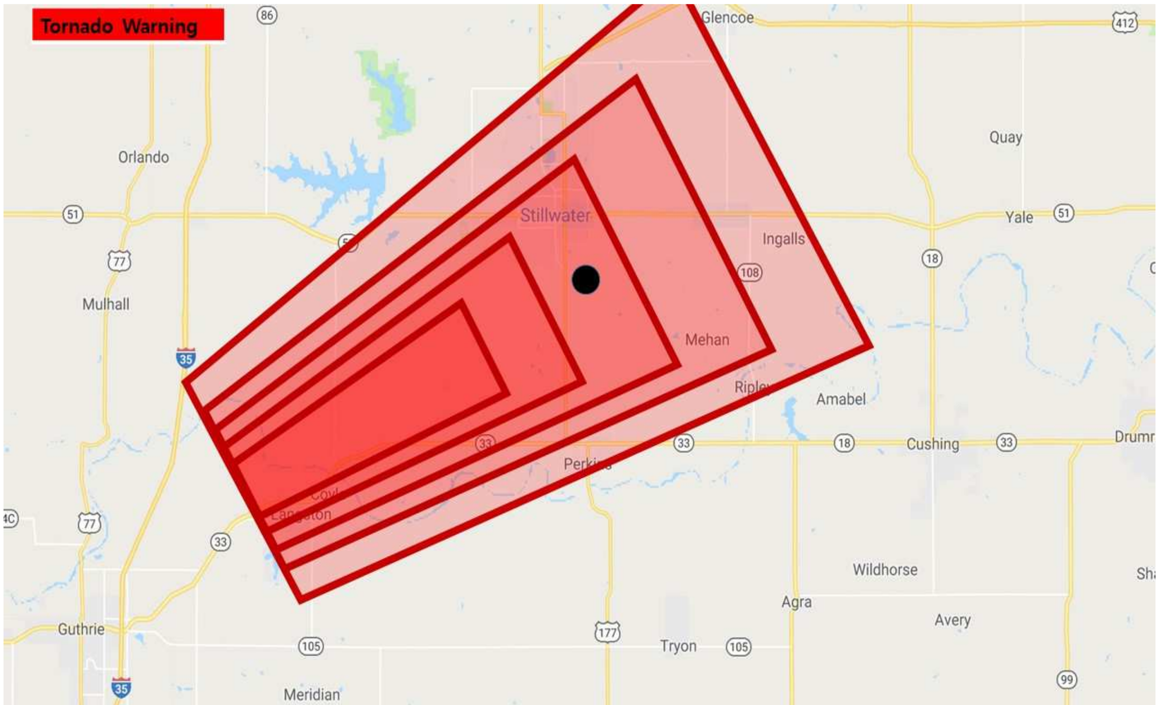
Advisory 1 (It is 2:00 PM, on March 3, 2020)



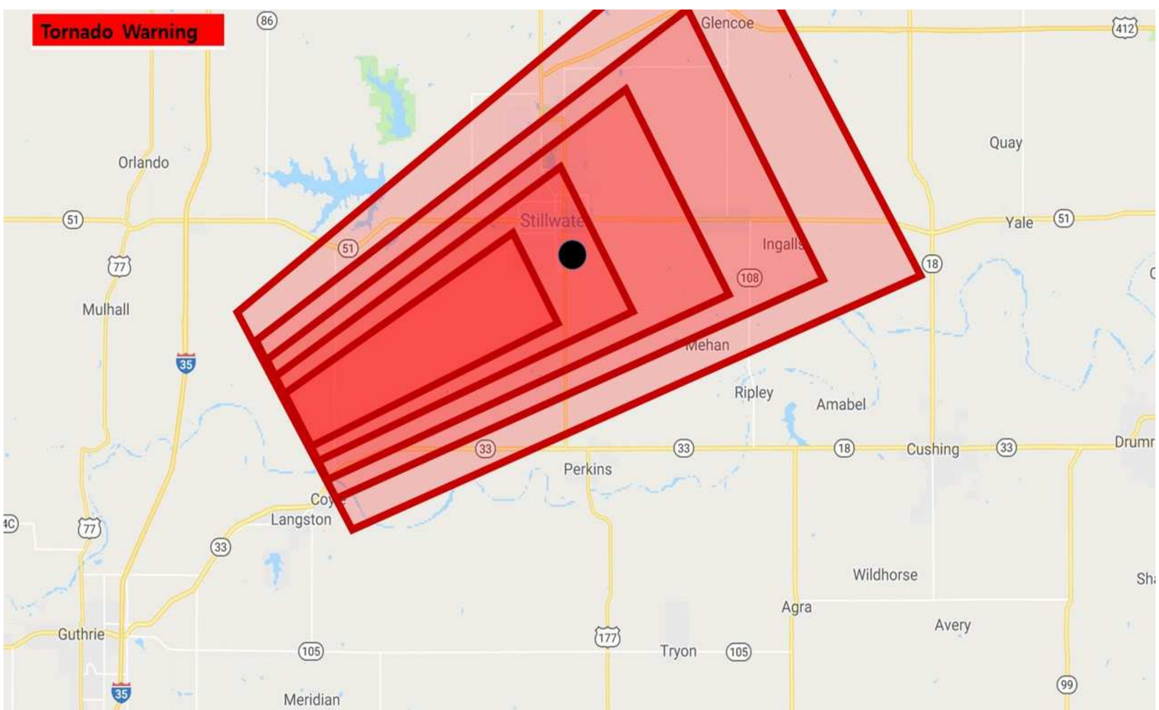
Advisory 2 (10 minutes has passed. It is 2:10 PM, on March 3, 2020)



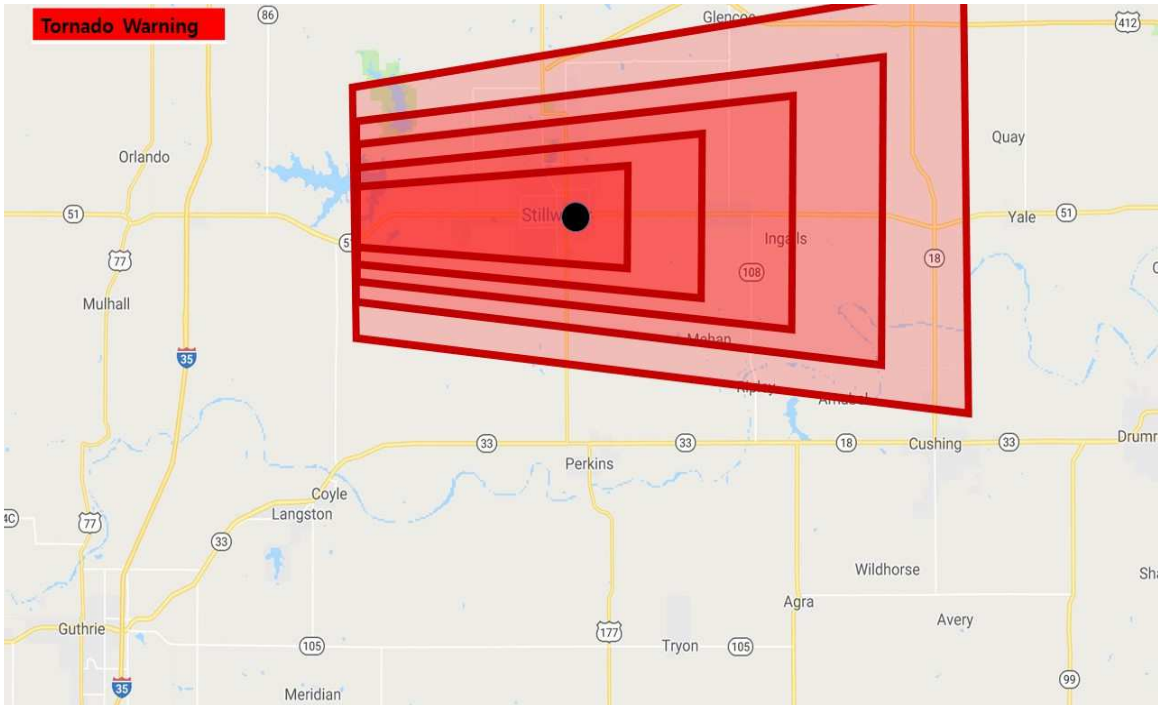
Advisory 3 (Another 10 minutes has passed. It is 2:20 PM, on March 3, 2020)



Advisory 4 (Another 10 minutes has passed. It is 2:30 PM, on March 3, 2020)

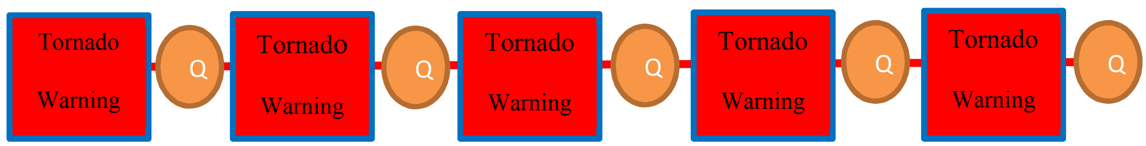


Advisory 5 (Another 10 minutes has passed. It is 2:40 PM, on March 3, 2020)

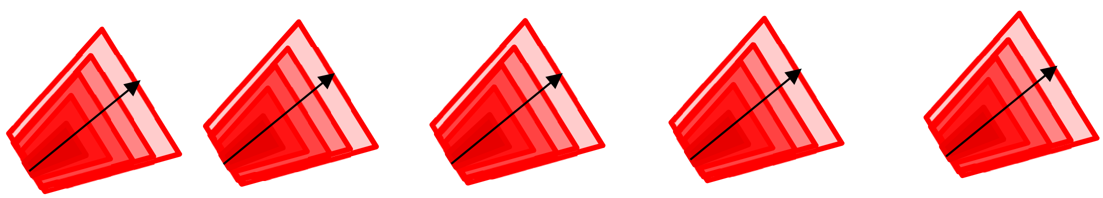


APPENDIX E: Group B Warning Scenario (Information Type 3)

Student Group A (N=139)

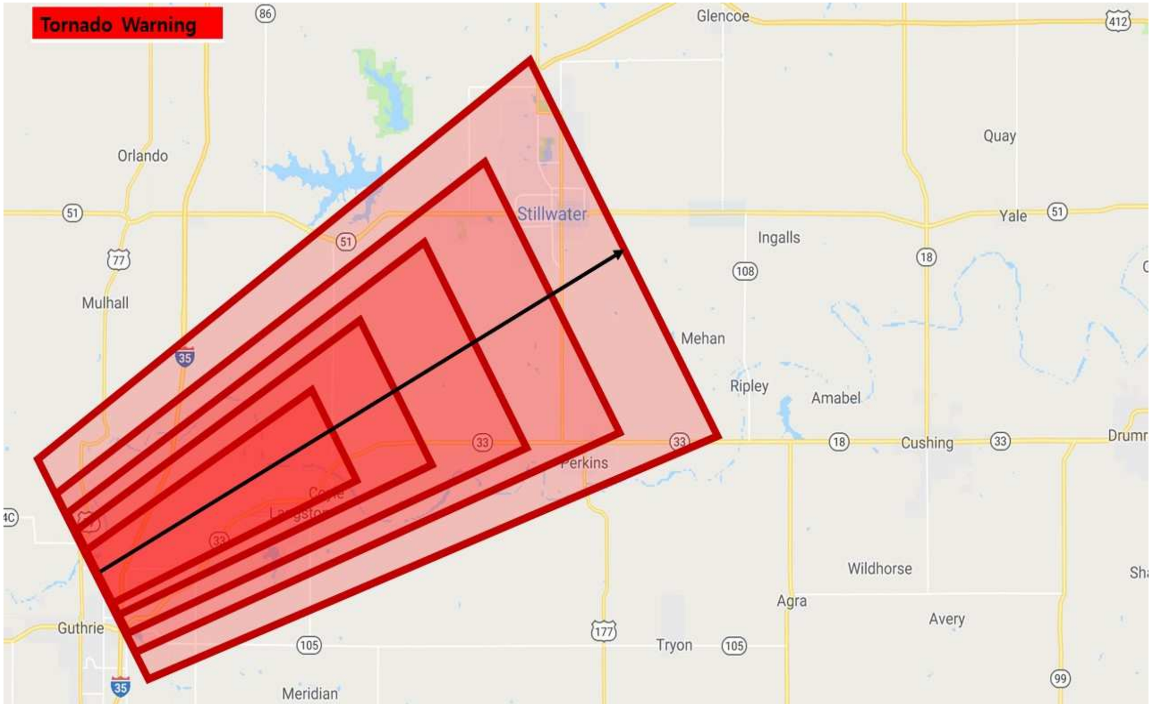


Red gradient polygon plus track-line (Information Type 3)

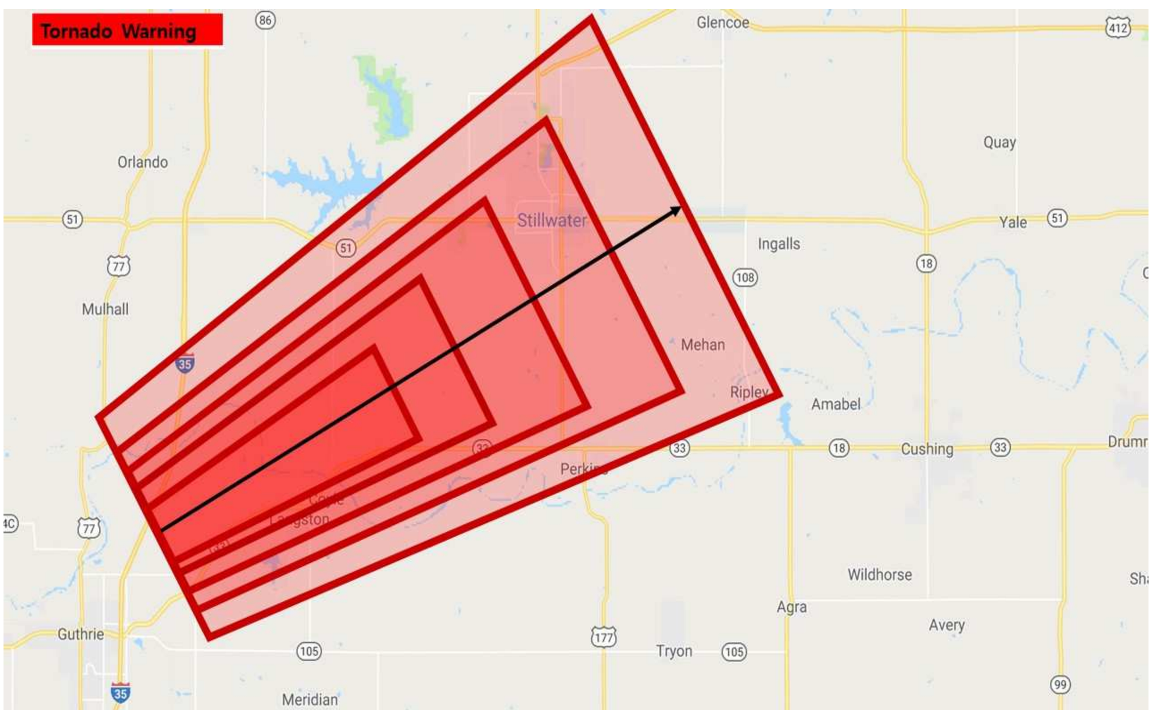


Advisory 1	Advisory 2	Advisory 3	Advisory 4	Advisory 5
(2:00 pm)	(2:10 pm)	(2:20 pm)	(2:30 pm)	(2:40 pm)

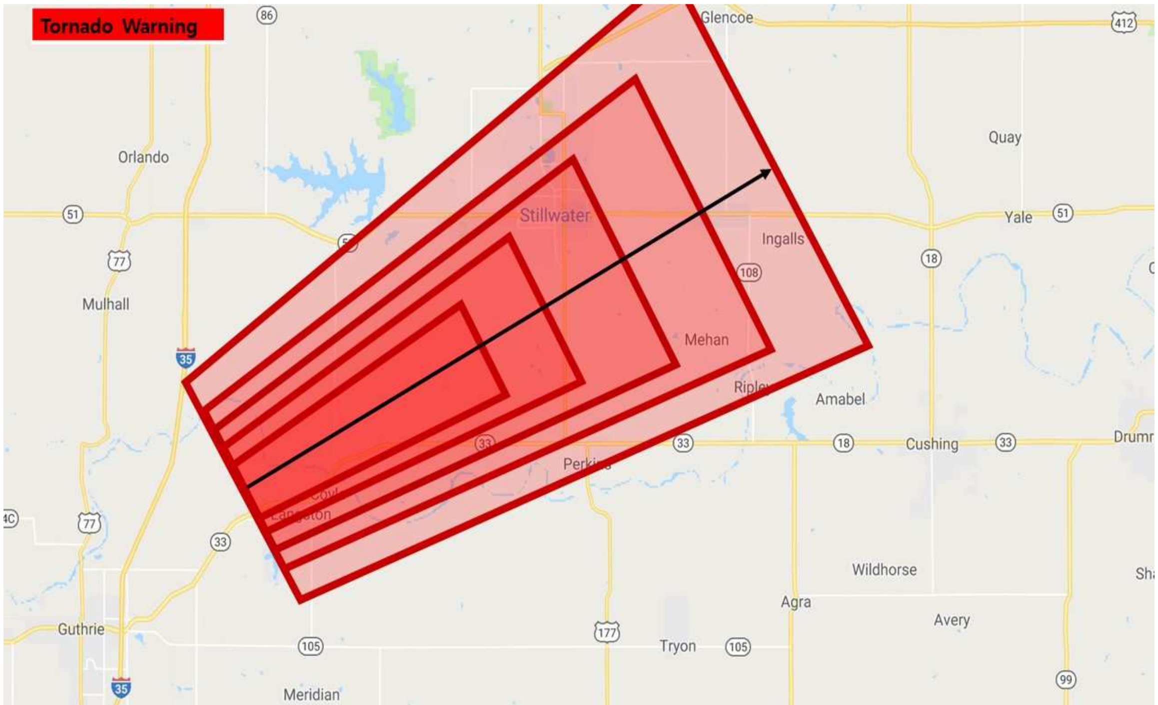
Advisory 1 (It is 2:00 PM, on March 3, 2020)



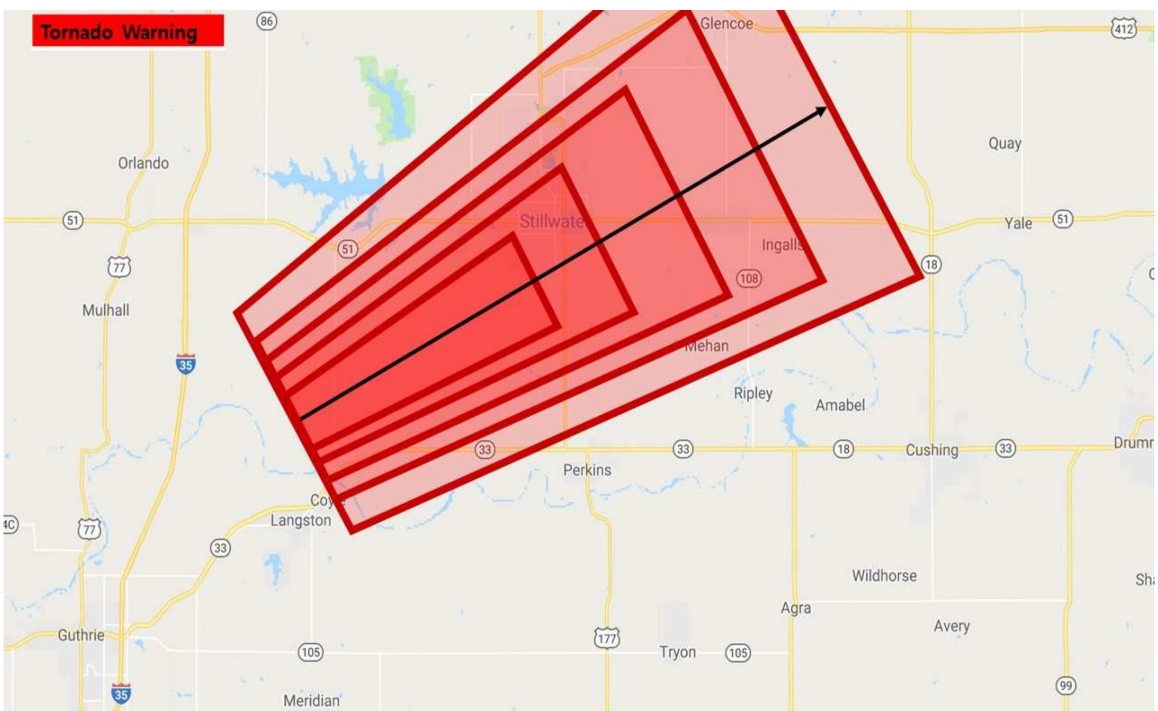
Advisory 2 (10 minutes has passed. It is 2:10 PM, on March 3, 2020)



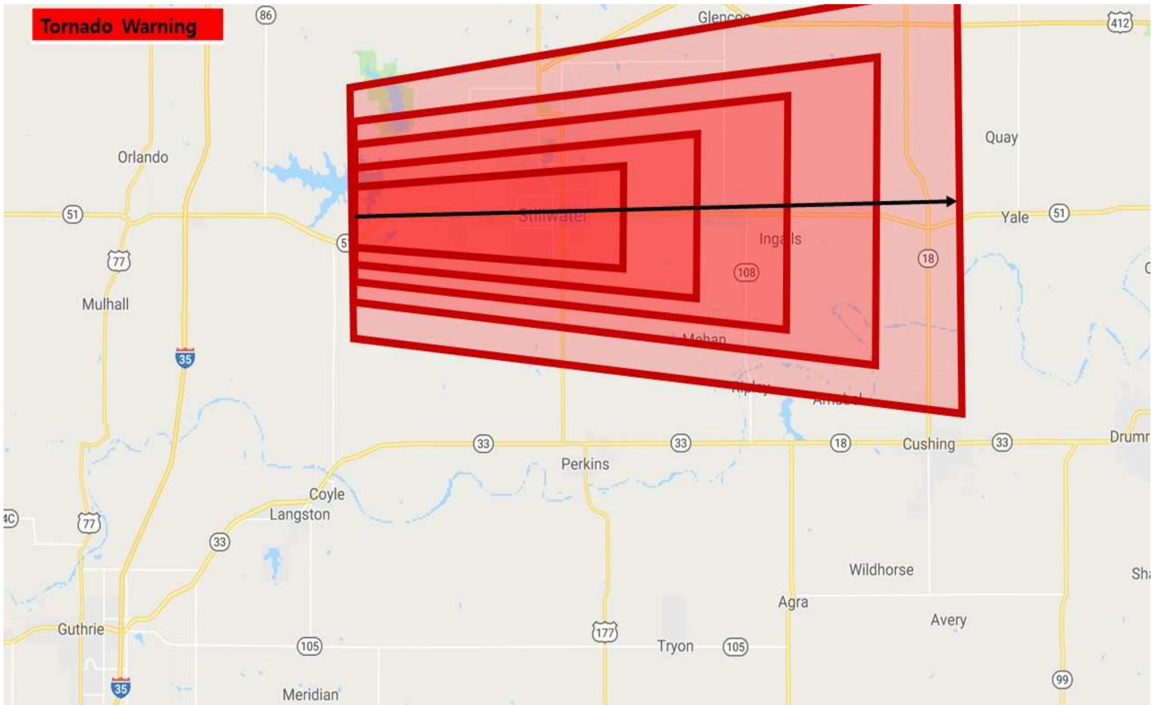
Advisory 3 (Another 10 minutes has passed. It is 2:20 PM, on March 3, 2020)



Advisory 4 (Another 10 minutes has passed. It is 2:30 PM, on March 3, 2020)

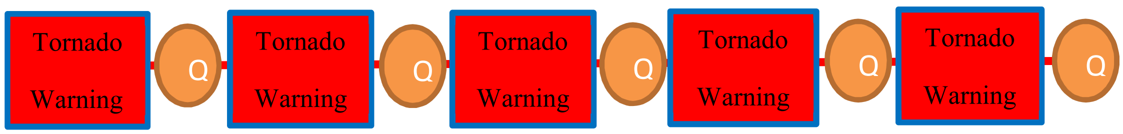


Advisory 5 (Another 10 minutes has passed. It is 2:40 PM, on March 3, 2020)

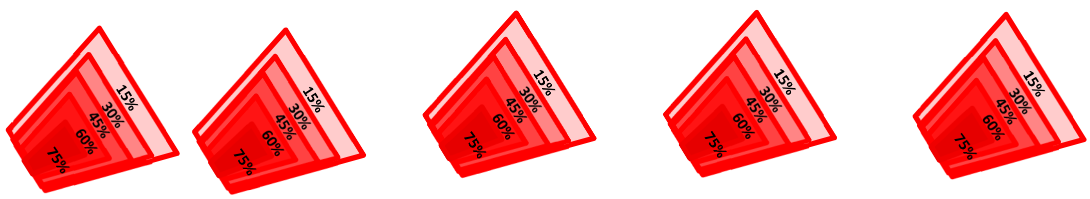


APPENDIX E: Group B Warning Scenario (Information Type 4)

Student Group A (N=139)

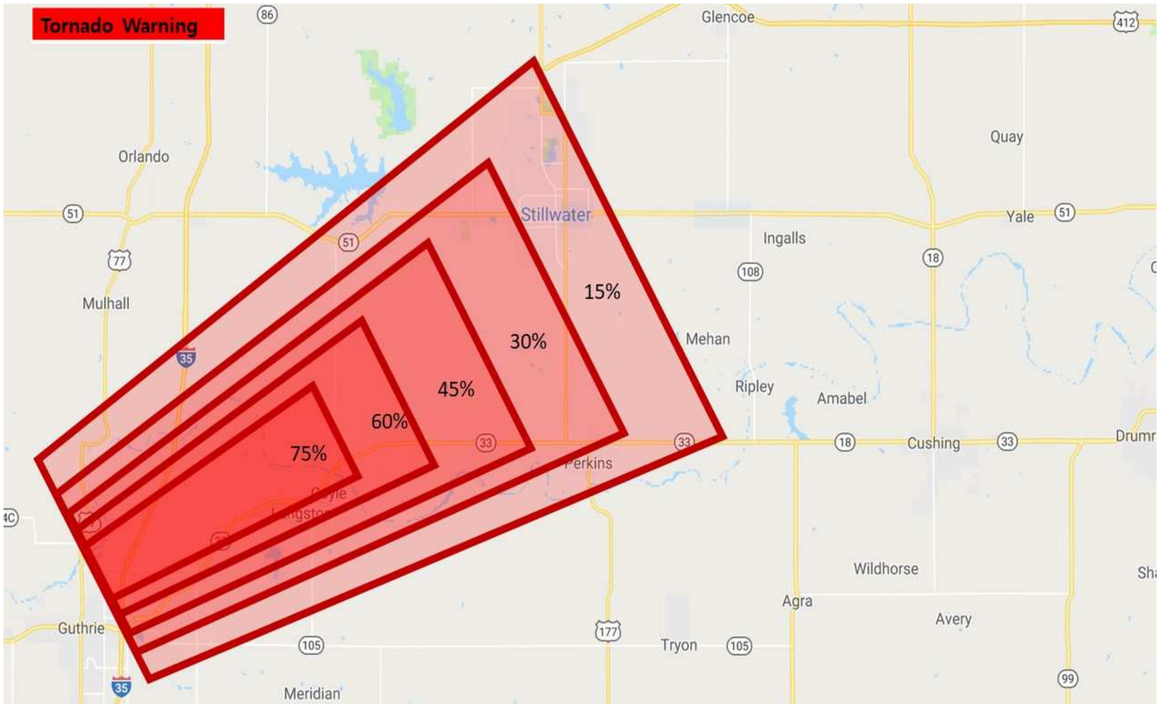


Red gradient polygon plus tornado strike probability (Information Type 4)

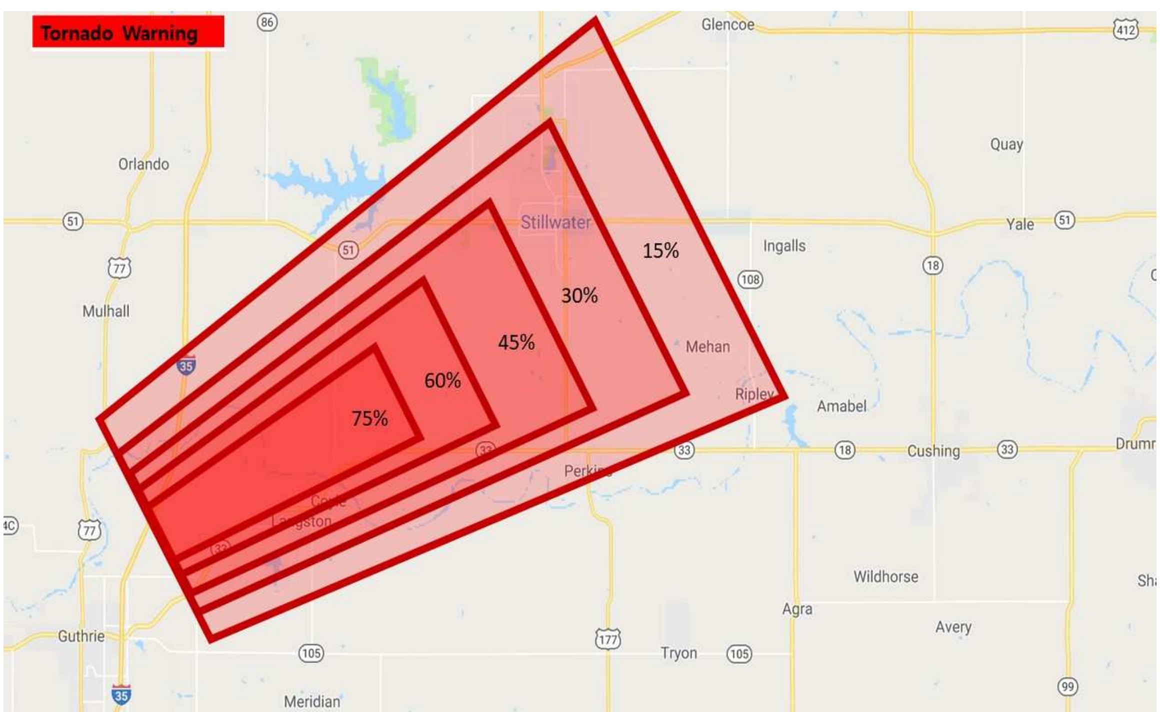


Advisory 1	Advisory 2	Advisory 3	Advisory 4	Advisory 5
(2:00 pm)	(2:10 pm)	(2:20 pm)	(2:30 pm)	(2:40 pm)

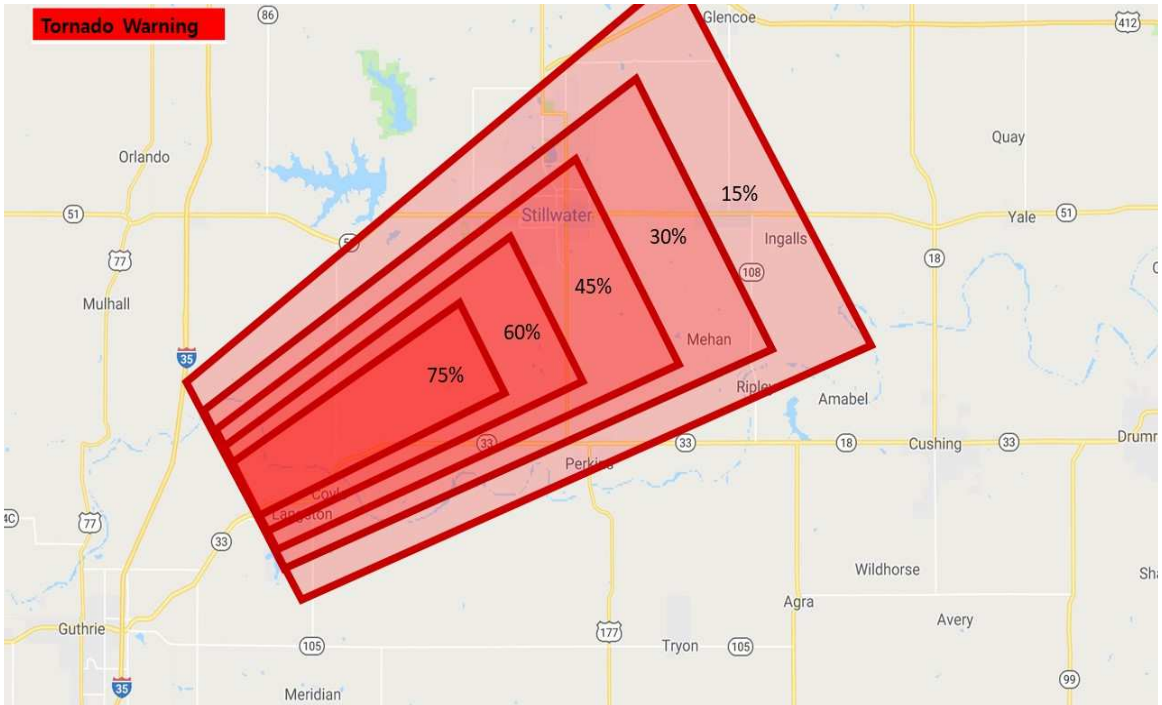
Advisory 1 (It is 2:00 PM, on March 3, 2020)



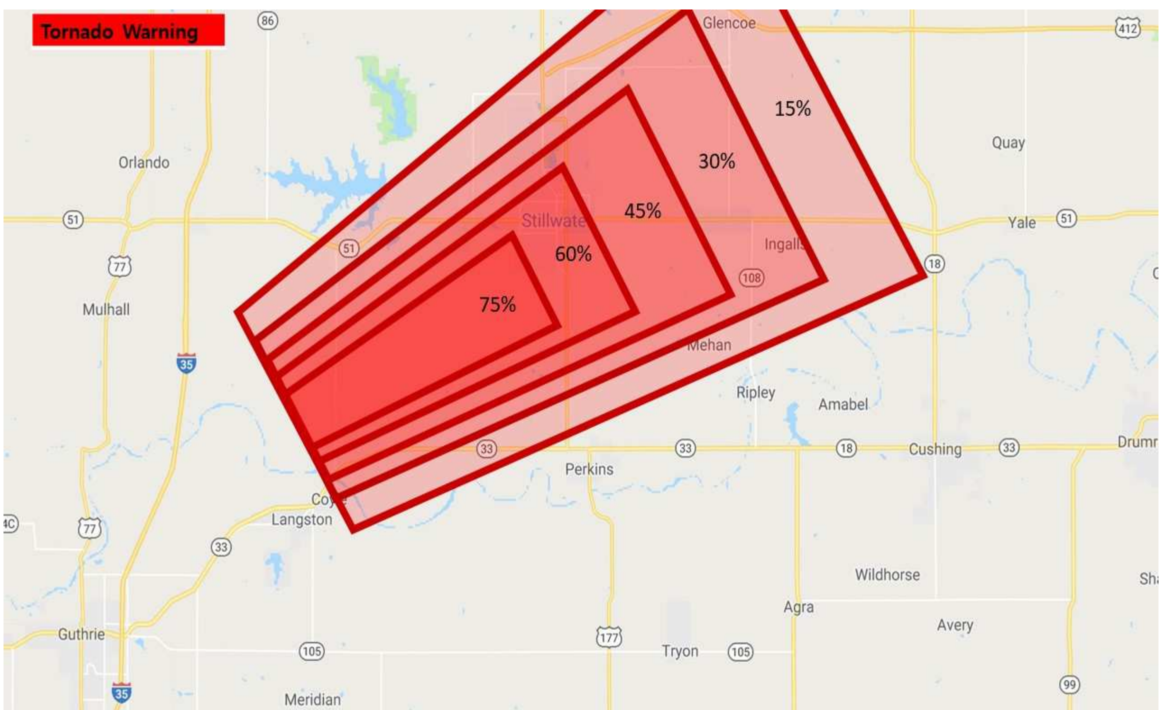
Advisory 2 (10 minutes has passed. It is 2:10 PM, on March 3, 2020)



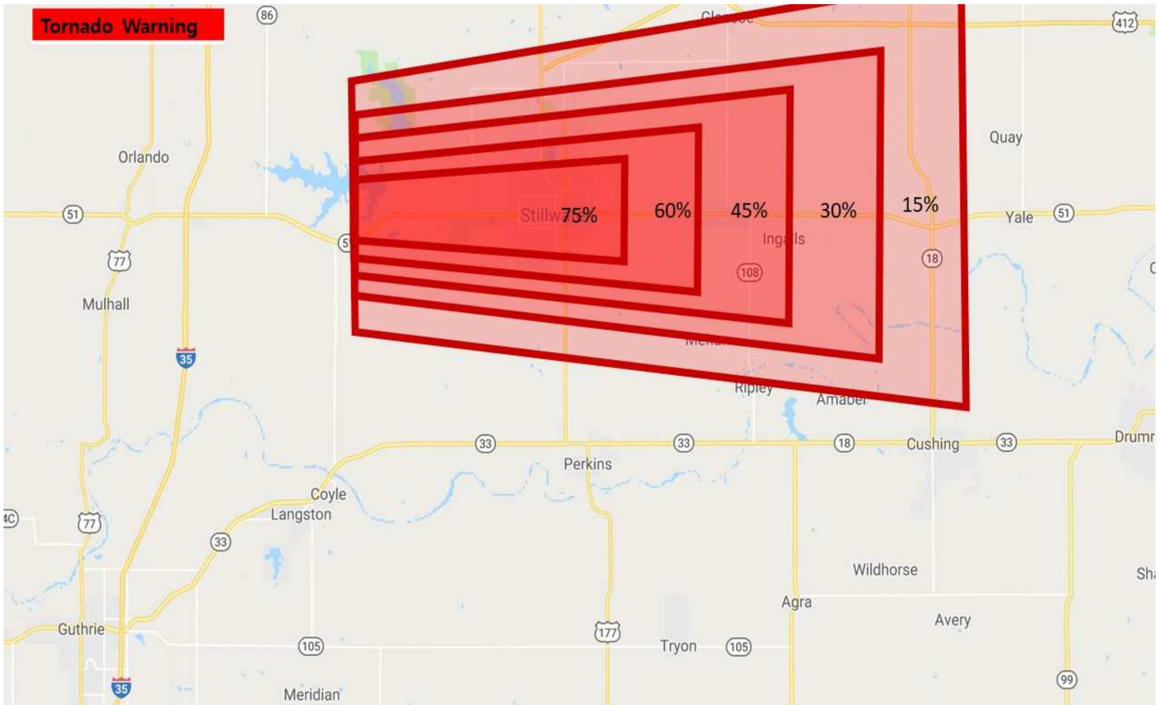
Advisory 3 (Another 10 minutes has passed. It is 2:20 PM, on March 3, 2020)



Advisory 4 (Another 10 minutes has passed. It is 2:30 PM, on March 3, 2020)

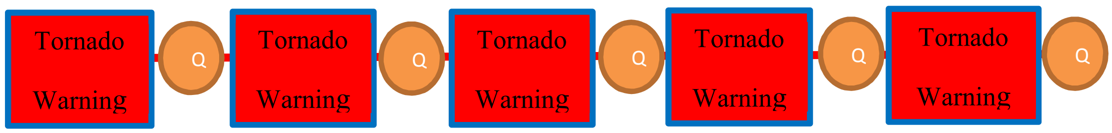


Advisory 5 (Another 10 minutes has passed. It is 2:40 PM, on March 3, 2020)

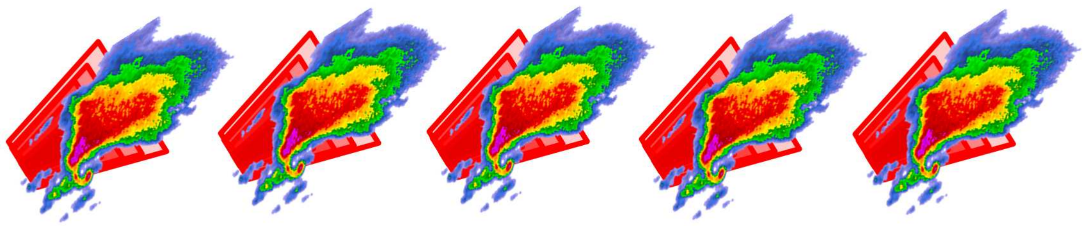


APPENDIX E: Group B Warning Scenario (Information Type 5)

Student Group A (N=139)

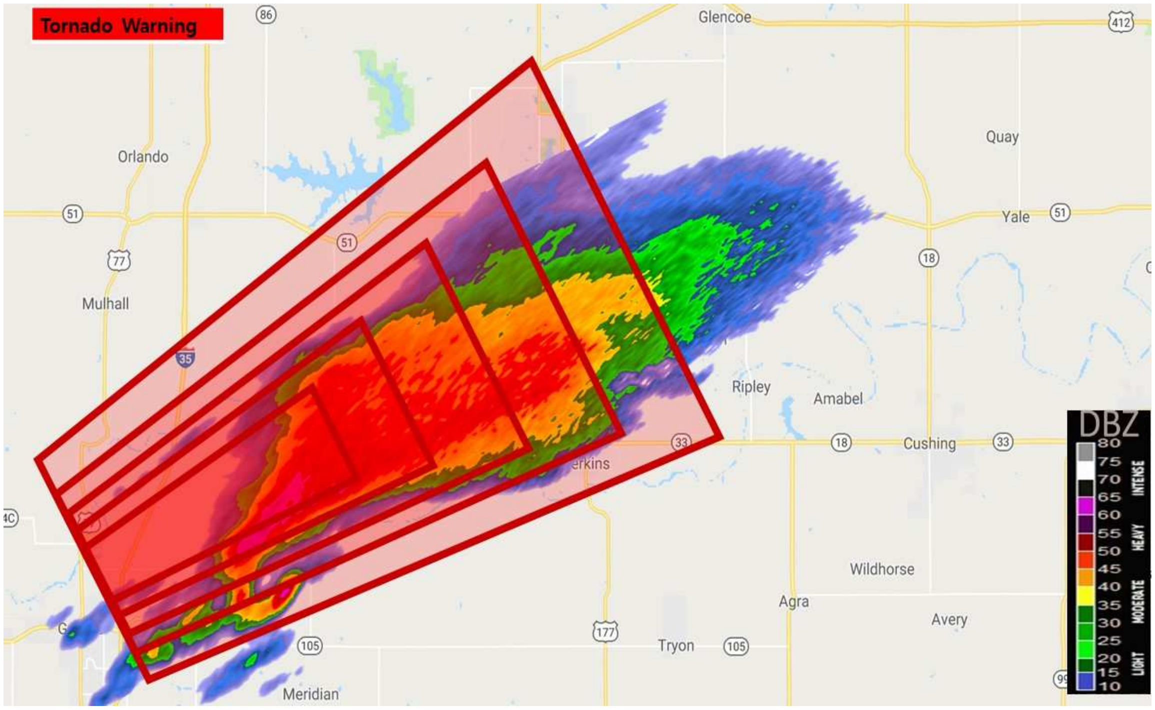


Red gradient polygon plus radar image (Information Type 5)

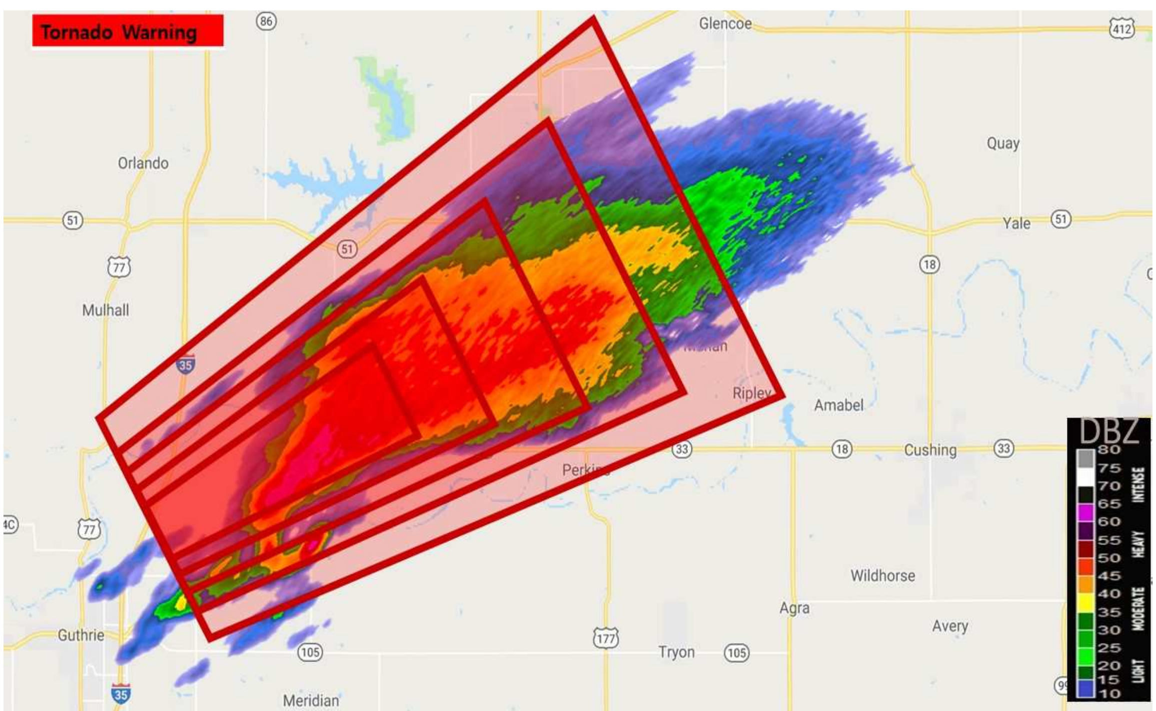


Advisory 1 (2:00 pm) | Advisory 2 (2:10 pm) | Advisory 3 (2:20 pm) | Advisory 4 (2:30 pm) | Advisory 5 (2:40 pm)

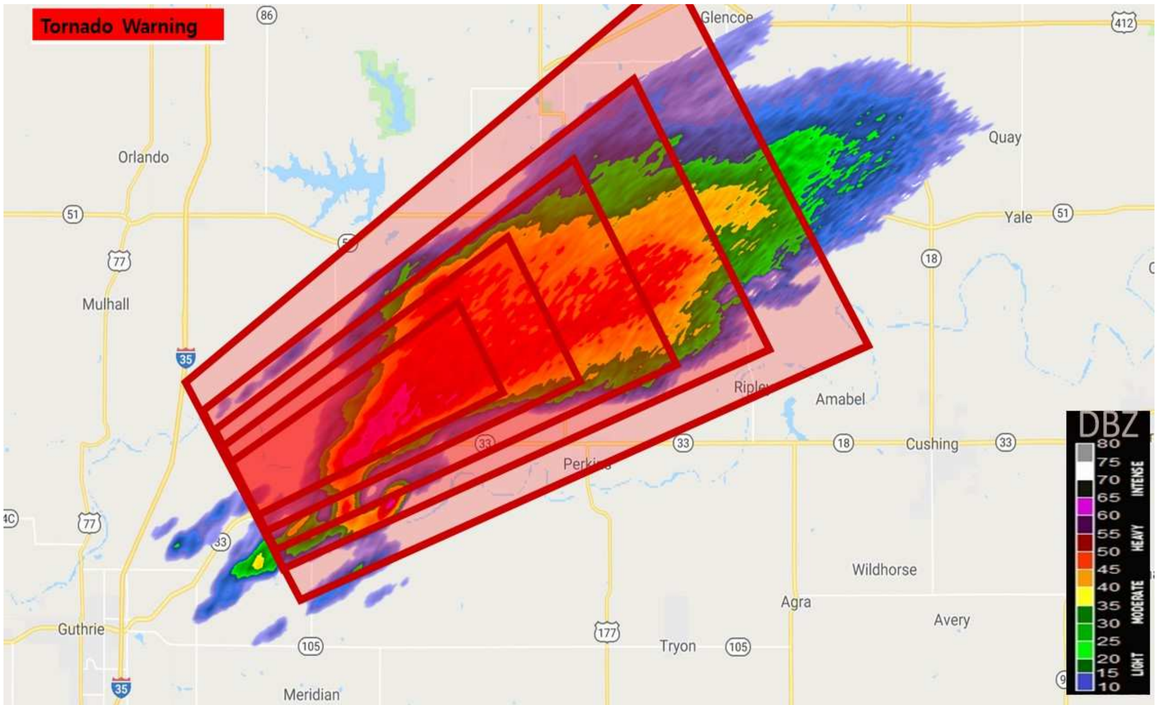
Advisory 1 (It is 2:00 PM, on March 3, 2020)



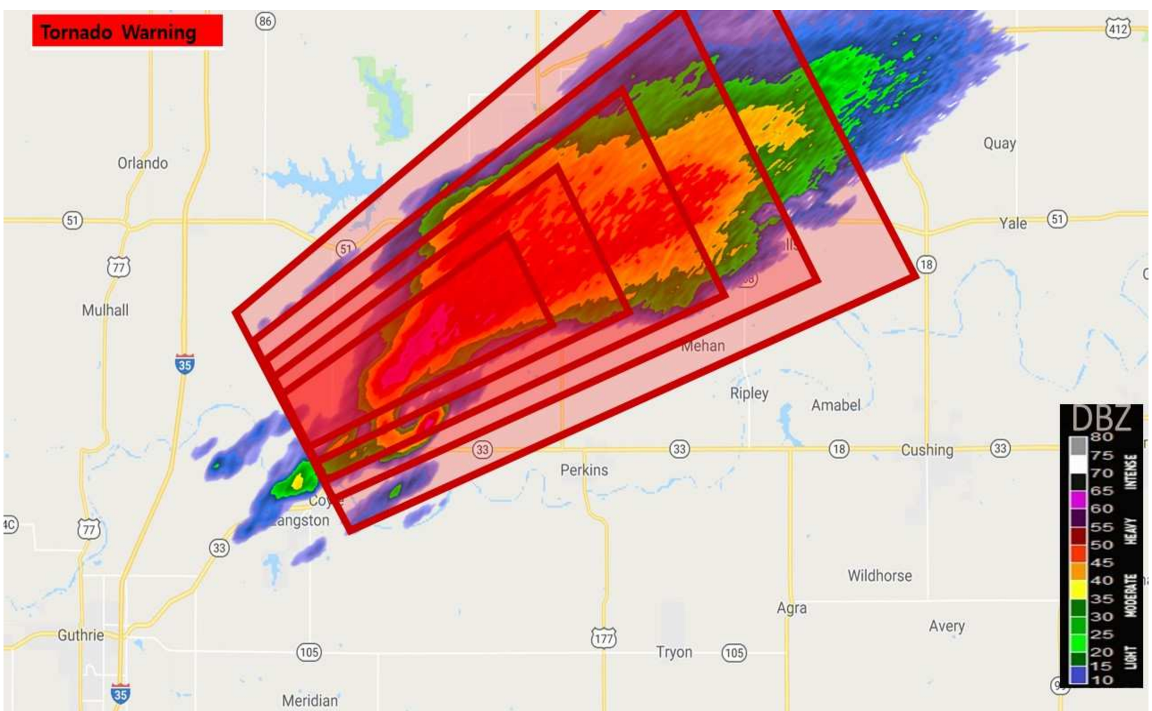
Advisory 2 (10 minutes has passed. It is 2:10 PM, on March 3, 2020)



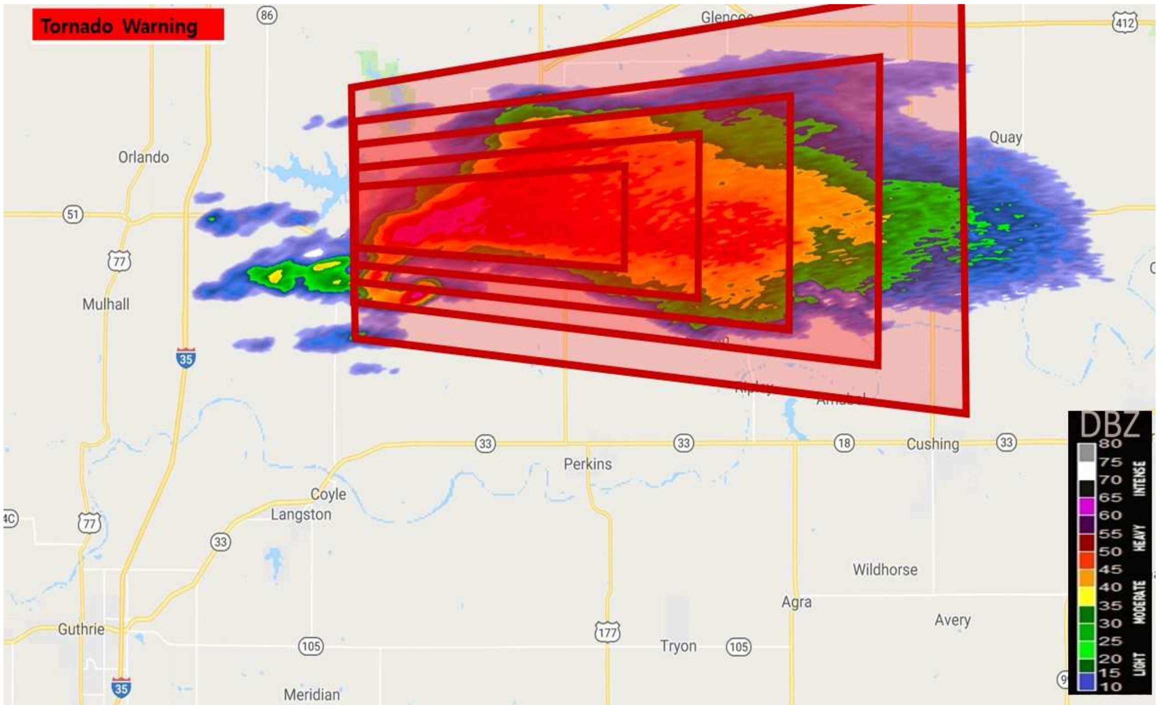
Advisory 3 (Another 10 minutes has passed. It is 2:20 PM, on March 3, 2020)



Advisory 4 (Another 10 minutes has passed. It is 2:30 PM, on March 3, 2020)



Advisory 5 (Another 10 minutes has passed. It is 2:40 PM, on March 3, 2020)



APPENDIX F: THE APPROVAL LETTER FROM THE OKLAHOMA STATE UNIVERSITY IRB

Oklahoma State University Institutional Review Board

Date:	11/08/2019
Application Number:	EN-19-25
Proposal Title:	Study on relationship between tornado risk information and protective action preference by comparing between international and domestic students
Principal Investigator:	Seongchul Choi, PH.D
Co-Investigator(s):	
Faculty Adviser:	Haley Murphy
Project Coordinator:	
Research Assistant(s):	
Processed as:	Exempt
Exempt Category:	

Status Recommended by Reviewer(s): Approved

The IRB application referenced above has been approved. It is the judgment of the reviewers that the rights and welfare of individuals who may be asked to participate in this study will be respected, and that the research will be conducted in a manner consistent with the IRB requirements as outlined in 45CFR46.

This study meets criteria in the Revised Common Rule, as well as, one or more of the circumstances for which continuing review is not required. As Principal Investigator of this research, you will be required to submit a status report to the IRB triennially.

The final versions of any recruitment, consent and assent documents bearing the IRB approval stamp are available for download from IRBManager. These are the versions that must be used during the study.

As Principal Investigator, it is your responsibility to do the following:

1. Conduct this study exactly as it has been approved. Any modifications to the research protocol must be approved by the IRB. Protocol modifications requiring approval may include changes to the title, PI, adviser, other research personnel, funding status or sponsor, subject population composition or size, recruitment, inclusion/exclusion criteria, research site, research procedures and consent/assent process or forms.
2. Submit a request for continuation if the study extends beyond the approval period. This continuation must receive IRB review and approval before the research can continue.
3. Report any unanticipated and/or adverse events to the IRB Office promptly.
4. Notify the IRB office when your research project is complete or when you are no longer affiliated with Oklahoma State University.

Please note that approved protocols are subject to monitoring by the IRB and that the IRB office has the authority to inspect research records associated with this protocol at any time. If you have questions about the IRB procedures or need any assistance from the Board, please contact the IRB Office at 405-744-3377 or irb@okstate.edu.

Sincerely,
Oklahoma State University IRB

APPENDIX G: STATEMENT OF INFORMED CONSENT

Statement of Informed consent

I understand that I am one of students participating in this study during the fall semester of 2019. The purpose of this experimental study is to explore relationship between tornado risk information and people's protective action preference. My participation will include tracking simulated tornado event with five weather advisories. This research study will last up to 60 minutes of my time.

The personal benefit for my participation is to learn more about tornado risk information and protective action decision. I understand that my participation is voluntary. I can stop my participation at any time simply by logging out the DynaSearch program. Withdrawal from the study at any step of the research process will not affect my relationship with the researchers or Oklahoma State University.

Participation in this study results in no predictable psychological or physical risk or discomfort. Participants' answers to the test questions will be stored securely at the Fire and Emergency Management Administration program office (Rm 505, Engineering North).

If I have any questions about this study, I may contact the investigator Ph.D. student Seongchul Choi (Rm 505, Engineering North, seongchul.choi@okstate.edu).

I understand this research study has been reviewed and approved by Oklahoma State University Institutional Review Board. If I have any research-related issues or questions regarding my subject's rights, I can contact Oklahoma State University IRB by calling (405) 744-3377 or emailing IRB@okstate.edu.

I have read and understood the explanation supplied to me. I have answered all my questions satisfactorily. I am presenting that I voluntarily agree to participate in this study by clicking "CONTINUE".

Approved: 11/08/2019
Protocol #: EN-19-25

APPENDIX H: HIRING MATERIAL

Dear Faculty

Hello,

I am Seongchul Choi.

I am a Ph.D student in the OSU Fire and Emergency Management Administration program.

I would like to ask a favor of you.

My dissertation studies the differences between international and U.S. domestic students on tornado risk information and protective action decisions.

To do this, I need to recruit 100 international and 100 U.S domestic students to participate in an online survey that we developed.

The following is the link to the survey. This should give you an idea about the project.

https://www.cs.clemson.edu/dynasearch/blind.php?expid=241&token=fA03qT0BaNG4Sqj6YJUuUlgoAppxICUO

I am currently working on my Human Subject IRB application.

My plan is to work with you and have your students participate in the study in class.

I am emailing to seek your support for this.

Please let me know if you are willing to support my project.

If you are, I will email you more information about my study once I have the IRB approval.

Please feel free to contact me if you have any questions.

Thank you very much.

Best regards,

Seongchul Choi

Approved: 11/08/2019
Protocol #: EN-19-25

VITA

Seongchul Choi

Candidate for the Degree of

Doctor of Philosophy

Thesis: TORNADO WARNING RESPONSE AMONG INTERNATIONAL AND DOMESTIC COLLEGE STUDENTS IN A DYNAMIC TRACKING TASK

Major Field: Fire and Emergency Management Administration

Biographical:

Education:

Completed the requirements for the Doctor of Philosophy in Fire and Emergency Management Administration at Oklahoma State University, Stillwater, Oklahoma in 2020.

Completed the requirements for the Master of Public Administration at Seoul National University Graduate School of Public Administration, Seoul, South Korea in August 2020.

Completed the requirements for the Bachelor of Public Administration at Korea University, Sejong, South Korea in 2001.

Experience:

Graduate Research Assistant, Oklahoma State University Division of Engineering and Technology, 2018-2019

Coordinator for 911 rescue service, Ministry of Public Safety and Security of South Korea, 2012-2013

Instructor, Kongju National University College of Nursing and Health, 2012

Professional Memberships:

International Association of Emergency Managers

National Fire Protection Association