Enhancing Threat: Using Cartographic Principles to Explain Differences in Hurricane Threat Perception

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Introduction

With local television stations in Florida sometimes providing over twenty-four hours of commercial-free coverage of hurricanes aimed at the state, residents are bombarded with images (Whitney, 2004). These images range from the almost-clichéd appearance of a rain-drenched reporter clutching a pole in one arm and a microphone in the other to an array of computer generated graphics delivered by the weathercaster.

Advancements in the ability to create and display weather graphics have made it possible for stations throughout the country to give the public live, up to the minute accounts and warnings during times of severe weather in ways that are visually appealing and eye-catching. News stations also routinely break into local programming to announce the threat of a tornado and show very detailed and colorful images that indicate where this tornado is, and where it is likely heading. Whether warning the audience of a tornado or hurricane, these graphics, as part of the message sent by the newscast, have a role in shaping the viewers' perceptions of the existing threat.

As part of the news, the images shown during the weather segment may have some role in shaping the audience's sense of reality. Stallings (1990, p. 87) states "journalists simultaneously create and perpetuate an image of reality when they assemble a news product." For this reason, and because people do turn to mass media in times of severe weather, it is important to understand the influence

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these weather images may have on peoples' perceptions, which become the realities they use to make decisions about the risk involved in a severe-weather event.

A potential problem in the use of weather imagery during severe weather is that little is known about the influence these graphics have in shaping perception and encouraging or discouraging action. The purpose of this study is to examine one type of image common to newscasts during a hurricane: satellite imagery. Infrared (IR) satellite imagery is often color enhanced to better show differences in cloud top temperature (Conway et al., 1997). Color codes for satellite enhancements are not typically provided during the weather segment of the news, however. Without provision of such a color code, one should not assume the audience has adequate knowledge about the enhancement to understand the images. This possible lack of understanding among viewers as to what the various colors mean combined with several display characteristics of the images themselves could lead to color enhanced satellite images having a different influence on perception than unenhanced IR images or visible images which show cloud thickness, and are not enhanced. Therefore, this study examines this possible difference through the use of a hypothetical hurricane situation. Before discussing the research however, it is important to establish a familiarity with some of the display characteristics of weather images, and how they might factor in shaping perception.

The Influence of Color in Weather Displays

Many of the elements responsible for the way one interprets a map are also applicable in weather displays. Weather displays such as the satellite image are in fact just one type of representation of the world (for a discussion of this, see Monmonier, 1999). For this reason, weather display characteristics will be examined through a cartographic lens. Additionally, this study focuses only on the use of color in the satellite image, although other factors might also prove important.

Recommendations on the appropriate use of color have had a long history in cartography (Brewer, 1994). Throughout this history, however, recommendations dealt primarily with notions such as the use of hue for qualitative differences and the use of lightness for quantitative differences (Brewer, 1994). Most of these recommendations had also been made with the printed map in mind. With the advancement of computer cartography, however, it became necessary to set guidelines that extended beyond the recommendations for the printed map. In 1993, the American Meteorological Society's Interactive Information and Processing Systems (IIPS) Subcommittee for Color Guidelines created a list of recommendations for color weather features. These guidelines included such recommendations as blue to denote cold fronts, and green to denote the occurrence of precipitation (IIPS, 1993). Even with such guidelines established, adding color to a display has certain impacts on the reader or viewer that require careful consideration by the image creator.

Monmonier (1991, p.147) stated, "Color is a cartographic quagmire." Colors help to make a map (as well as a weather image) more attractive, but can also be deceptive. The use of color on a map or image can have both positive and negative effects on the ability for one to "read" it. It is easier to search a display for colors than symbols, and it is easier to count colored targets than those varying only in size or value (gray tone) (Hoffman et al., 1993). This is due to color's ability to be retrieved rapidly from memory, as well as its ability to be distinguished by that part of vision consisting of both rods and cones together, which provides lower resolution sight, and where form is indistinct (Carter, 1982). It is also possible to discern more different hues in a display than various degrees of lightness or value of a gray scale (Mersey, 1990).

A potential negative aspect of the use of color in a map is that sequences of varying hues (the property of a color by which one commonly recognizes it-- red, green and purple for instance, as defined by its wavelength) have no single consistent ordering (Monmonier, 1991). For this reason, hue is not usually used to portray quantitative differences on a map. It is often used to denote qualitative differences, however, which are not ordered. Another problem with color is that of simultaneous contrast (Slocum, 1999). Simultaneous contrast is a phenomenon in which the appearance of one color is affected by the proximity of another color. This occurs because one color's value (brightness) when surrounded by another will shift in value to enhance the contrast (Mersey, 1990). For instance, when gray is surrounded by green, the gray appears reddish, but when surrounded by blue, the gray appears yellowish (Slocum, 1999).

When adding color to a display, one should also consider the conventions and cultural connotations associated with colors. For instance, there is a strong convention in map making and interpretation that dark equals more of something, or a higher magnitude, while light equals less magnitude; "the darker, the more" according to Mersey (1990, p. 1). Other conventions exist dealing with color's role as a landscape metaphor. These associations include green with vegetation, blue with water, and yellow with a desert environment (Monmonier, 1991).

Furthermore, colors may have certain cultural associations. Red may be used to denote warnings, for example, while yellow and green denote caution and safety respectively (Hoffman et al., 1993). Also, there are powerful associations of blue with cold and red with hot (Monmonier, 1991). Little is know about subjective reactions to color on maps besides standard conventions which include the association of red with "fire," "warning," "heat" and so on (Monmonier, 1991, p. 153). Although not necessarily negative, color connotations can work to a display's disadvantage if not used properly. Monmonier (1999, p.136) discusses this issue as it pertains to the assignment of false colors to weather images. He states that,

> Electronic image processing, which can sharpen details and assign colors to non-visible wavelengths, confers artistic license either to highlight noteworthy differences in the data, or to exploit cultural associations of navy blue with water and green or brown with land. This power to radiation intensities and estimated quantities like precipitable moisture can help readers either use the map key to decode conditions at specific places...or dramatically reify storms and their surroundings.

The concept of a figure-ground relationship is another basic cartographic principle that should be considered when creating a map or weather image. Similarly saturated colors are usually grouped together as either background, or theme (Robinson et al., 1995). Figure-ground relationship explains why when one looks at a map of North America one sees the continent as separate from the ocean. Experiments using figure-ground relationship have demonstrated that search time for a target on a display is shorter when the target images are placed on dissimilar or no backgrounds, but that search time increases when backgrounds are similar to the targets (Carter, 1982). Furthermore, since visual search of a display is completed through a number of fixations, modeling of this process indicates that extraction of information from the image is improved when the figure is conspicuous (Dobson, 1985). Thus, objects that stand apart from their backgrounds are processed more efficiently.

Closely related to the concept of figure-ground relationship is the notion that some colors appear to retreat while others appear to advance (Robinson et al., 1995). Saturated, high value reds, oranges and yellows are more likely to be seen as the figure on a map due to their advancing appearance. Low value, or less saturated greens, blues, browns and grays on the other hand are more likely to be viewed as background due to their retreating nature (Robinson et al., 1995). This process is in part due to a physiological phenomenon causing light rays entering the eye to be refracted in an inverse proportion to their wavelengths (Robinson et al., 1995). Also responsible are the red cones in the eye, because they are more numerous than green or blue cones.

Several of the concepts discussed above provide a framework for one to question the influence of weather images that assign false colors to various phenomena on perception. The enhanced IR satellite image, for instance, uses highly saturated warm colors such as reds and yellows to highlight areas in the cloud mass where cloud top temperatures are coldest. The unenhanced visible image, however, uses a gray scale to show differences in cloud thickness. Color enhancement could have profound effects on perception of the IR image by the untrained observer, especially when compared to an unenhanced visible image. The use of colors that normally connote danger or caution, such as in the enhanced IR image, could immediately suggest to the observer that they are viewing a dangerous situation, even if no danger exists. Also, placing an enhanced satellite image on a blue background, such as many television stations do, could cause the image to stand out more when viewed quickly due to figure-ground relationship and the advancing properties of the colors in the image compared to the retreating colors of the base map. Compared to the IR image, the visible satellite image composed of white and gray is more difficult to differentiate from the blue background and may not provoke the same amount of attention.

The combined interaction of several of the display characteristics in the IR image that are not present in the visible image provide reason to suggest that color-enhanced IR images will be perceived as more threatening than unenhanced visible images. This is due to the IR image's use of colors that suggest danger, its more pronounced figure-ground effect, and its juxtaposition of advancing warm reds against a cool blue background. These factors present in the enhanced IR image and not the unenhanced visible image lead to the first hypothesis.

Hypothesis 1: Color enhanced images will be perceived as more threatening than unenhanced visible images.

The Influence of Storm Characteristics

One must also consider the characteristics of the storm itself when attempting to determine how different images influence perception. Literature on what factors of the storm itself influence threat perception helped in the creation of the survey used in the study. After examining previous research, Lindell and Perry (1992, p. 149) concluded that public perception of natural hazards could be organized into four categories: "characteristics of the hazardous agent, characteristics of impact, perceived personal consequences and affective reactions to the hazard." They also found that much of the literature supports four predominant characteristics of threat, which influence individual's motivation to respond: severity, certainty, immediacy and duration of impact (Lindell & Perry, 1992). These factors were considered along with the image characteristics in the attempt to measure respondents' perceptions of the hypothetical hurricane threat.

One of the characteristics, severity, takes into account the size of the risk. Sandman et al. (1998) state that the effectiveness of risk explanations should not be studied without considering the size of the risk. Often literature offering explanations of public behavior or perception includes cases with more than one level of severity (Sandman et al., 1998 and Baker, 1995). This study therefore included two levels of severity, a category two hurricane and a category four hurricane. Intuitively, events with a greater degree of severity will be perceived as more threatening. This leads to the second hypothesis.

Hypothesis 2: The category four hurricane will be perceived as more threatening than the category two hurricane.

Methodology

To examine these hypotheses, a survey instrument was created that would measure a respondent's perceptions of a hypothetical hurricane. Participants would be given one of four survey types based on the level of severity (category two or four), and type of image (color enhanced IR or unenhanced visible). Before administering the survey, however, the researcher believed it best to ascertain that the questions to be asked on the survey actually measured what variables they intended to measure. To accomplish this, a series of focus groups was run using undergraduate students. Using the results of the focus group discussion, a final survey was created and administered. Undergraduate students were used in the focus group because they would comprise the sample used in the survey research.

Focus group

The purpose of the focus group was to create a better survey instrument. Beyond that broad purpose, however, the two focus group discussions had three primary goals: (1) to acquire a better sense of what attitudes might be present in the study population that might predispose respondents to perceive more or less threat regardless of the level of severity or image shown; (2) to analyze the list of descriptive words the researcher planned to use in the survey as well as the types of question planned; and (3) to evaluate the images created for the survey. With these goals in mind, each focus group's discussion time of two hours was divided into three parts. The first part of the discussion focused on weather; initially weather in general and then severe weather specifically. During the second part of the focus group discussion, participants were given a list of forty-five words. They were told to group these words together as they saw fit. Next, participants were asked to think of these words in terms of their ability to describe something negative. This enabled the researcher to see how such words could be used to describe a hurricane image. Finally, participants were given the opportunity to examine several satellite images of hurricanes, both IR and visible. Participants were then asked for their opinions and first impressions of these images so the researcher could determine whether the images were indeed realistic representations of a hurricane.

The focus group discussions resulted in several important outcomes. The discussion forced the researcher to modify several questions on the preliminary survey dealing with attitudinal variables to account for a range of attitudes towards weather that emerged in the focus group participants classified as "attentiveness" to "non-attentiveness." These attitudes can be conceptualized as the degree of importance and dependence one placed upon weather, as well as the level of interest one had in severe weather. Those participants in the focus groups who showed a low level of weather attentiveness had little experience viewing weather graphics on television. For example, some did not know the difference between the radar images shown on the *Weather Channel* and the satellite images shown to them during the focus group. This lack of basic satellite image understanding led to the following research question, as well as the consideration of attentiveness as a variable in the survey.

> *Research Question: What influence, if any, will the respondents' level of weather attentiveness have on their perception of the hurricane image in the survey?*

Focus group discussion also led to the creation of a smaller list of descriptive words. The nine words chosen--*attractive, boring, bothersome, confusing, horrible, peaceful, scary, vibrant* and *worrisome*-- were used on the survey to represent the degree to which the image respondents received was positive, negative or annoying.

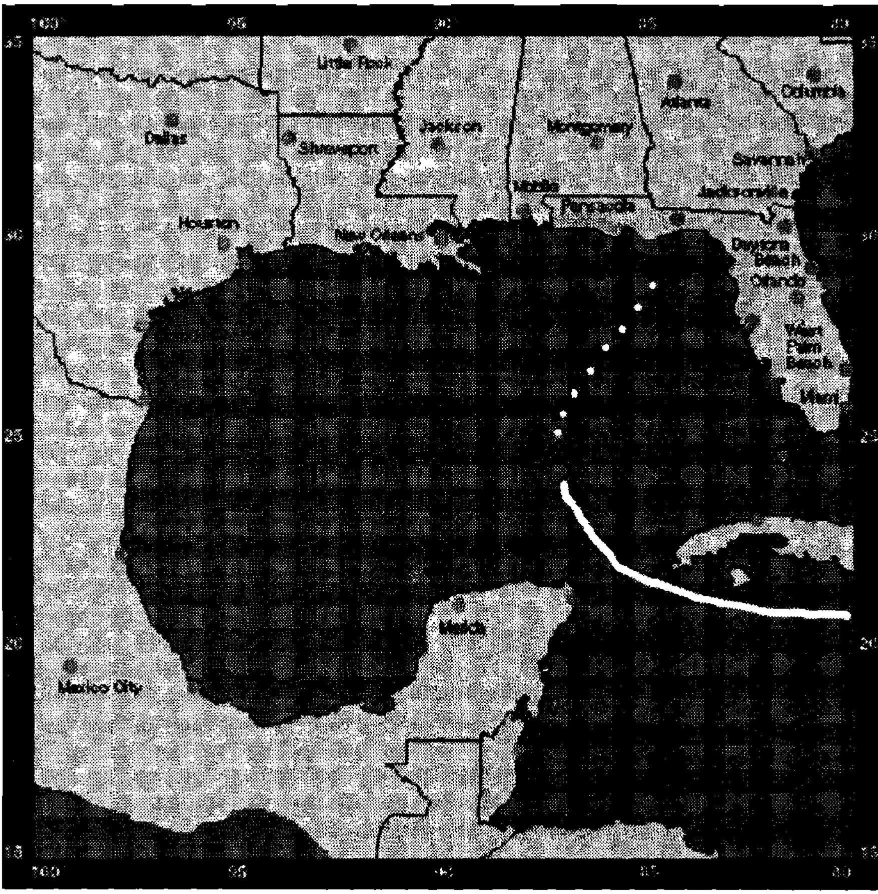
These specific words were selected from the larger list of forty-five because participants used these words most frequently to describe something positive, negative and annoying. Finally, participants agreed that the hurricane images to be included in the survey indeed appeared realistic. One participant also confirmed the researcher's early hypothesis that color enhancement increases the level of threat perceived with a shout of "Wow that looks really bad!" when shown the color-enhanced IR image.

Survey

The preliminary survey instrument was then modified given the results of the focus groups. To obtain a sample for this project, students were recruited to participate from seven classes offered by the communications and the geography departments at a large state-funded institution in Florida. One of these classes was taken by students of all majors; predominantly communication and geography majors took the remaining six classes. A total of 254 students were recruited and gave their permission to take part in the survey. Once consent was obtained, students were directed to the researcher's website (*http://www.msstate.edu/courses/kms5/hurricane.html*)[1] to complete the survey online. Students could visit the site either by typing in the address in the top of their browser or by clicking on a link sent to them via e-mail.

The survey consisted of twenty-five questions arranged into two general sections. Section One attempted to create a profile of the respondents' attitude towards weather and past behavior during hurricanes. Some of these statements reflected the attitudes that emerged during the focus group discussions. Questions one through nine asked respondents to respond to statements about their attitudes towards weather using a Likert scale. For instance, one of the statements read, "I believe it is important to be informed about the weather." Questions ten through thirteen asked respondents about their actions taken during two tropical systems that made landfall in Florida during September and October 2000, and during other hurricanes by which they were affected.

Figure 1. Forecast track map. All survey participants were shown this image (in color) of hypothetical Hurricane Zeke located in the Gulf of Mexico, forecast to make landfall in Florida. The dark shading along the coast indicates a hurricane warning, while the light shading indicates a hurricane watch in effect. The survey contained a statement explaining what these colors meant along with the image. For the full-color image, please visit the webpage at http://www2.msstate.edu/~kms5/survey/watch_warn.jpg.



Section Two presented respondents with a hypothetical hurricane scenario and sought to measure the amount of threat they perceived from the information they were given. Before completing the remaining questions, respondents were asked to read a paragraph describing a hypothetical hurricane situation. All surveys included this brief descriptive paragraph about the hurricane along with an image showing the forecast track. This image (Figure 1) contained a map of the Gulf of Mexico with the surrounding states and the probable track of hypothetical Hurricane Zeke. Close to half of the respondents would receive information about a category two hurricane while the remaining respondents would receive information about a category four hurricane. The first image remained the same for each respondent. The descriptive paragraph varied slightly according to the severity of the hypothetical hurricane. The second image respondents viewed in Section Two contained the same base map, but had a hurricane satellite image (from the National Climate Data Center's Historical Significant Events Imagery archive) superimposed upon it. Roughly half of the surveys would contain a visible satellite image in which the hurricane appeared in gray-scale (Figure 2), while the remaining surveys would contain a color-enhanced IR image (Figure 3). Thus the respondents could have received one of four possible survey versions henceforth referred to as surveys *a* through *d*. These versions combined the two image types with the two hurricane categories. Ideally, these four versions would be divided equally among the respondents.[2]

The purpose of Section Two was to determine whether the image that respondents received had any influence on the rating students assigned to questions measuring threat. Threat was measured by respondents' ratings of a series of factors based on two of the four characteristics of threat—severity and certainty—which, according to Lindell and Perry (1992), influence an individual's motivation to respond. Other questions asked respondents to rate the images they received based on the appropriateness of the nine descriptors and then to decide what actions would be necessary if the hypothetical hurricane had been a real event. Finally, respondents were asked demographic questions as well as questions pertaining to weather informa-

Figure 2. Visible, unenhanced satellite image. Half of the respondents received this visible image (with base map and ocean in color), and were told it was either a category 2 or a category 4 hurricane. For the full-color image, please visit the webpage at http://www2.msstate.edu/~kms5/survey/VIS_Hur.jpg.

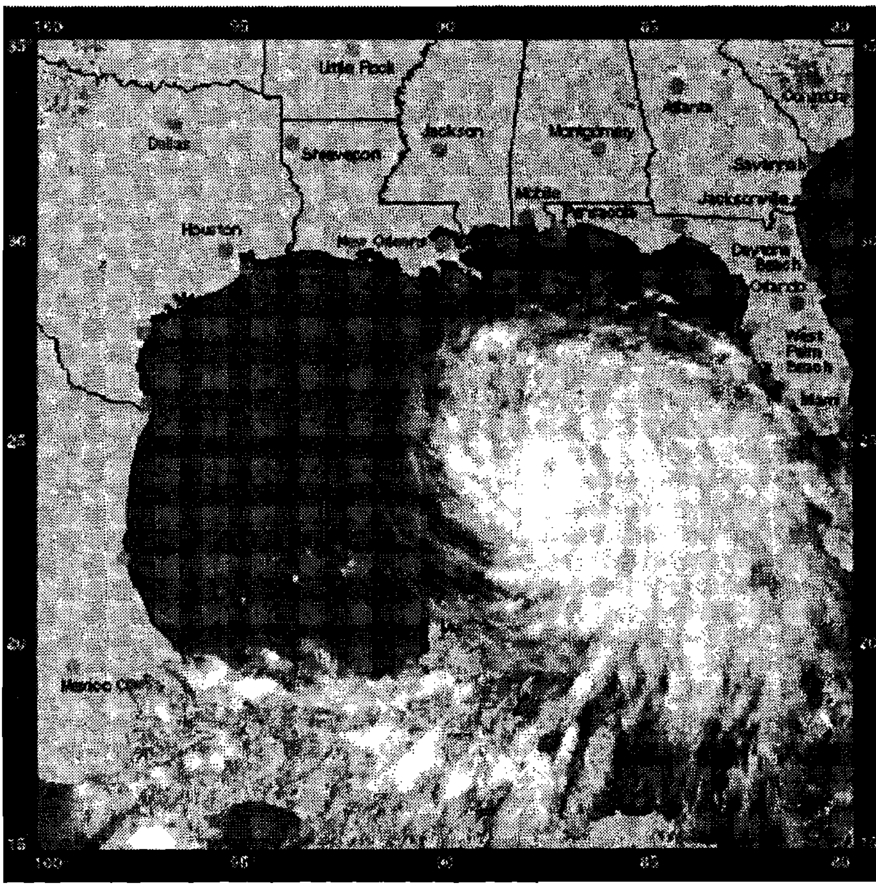


Figure 3. Enhanced IR satellite image. Half of the respondents received this infrared image (in color on the webpage), and were told it was either a category 2 or a category 4 hurricane. No information was provided about what the colors indicated. For the full-color image, please visit the webpage at http://www2.msstate.edu/~kms5/survey/IR_Hur.jpg.

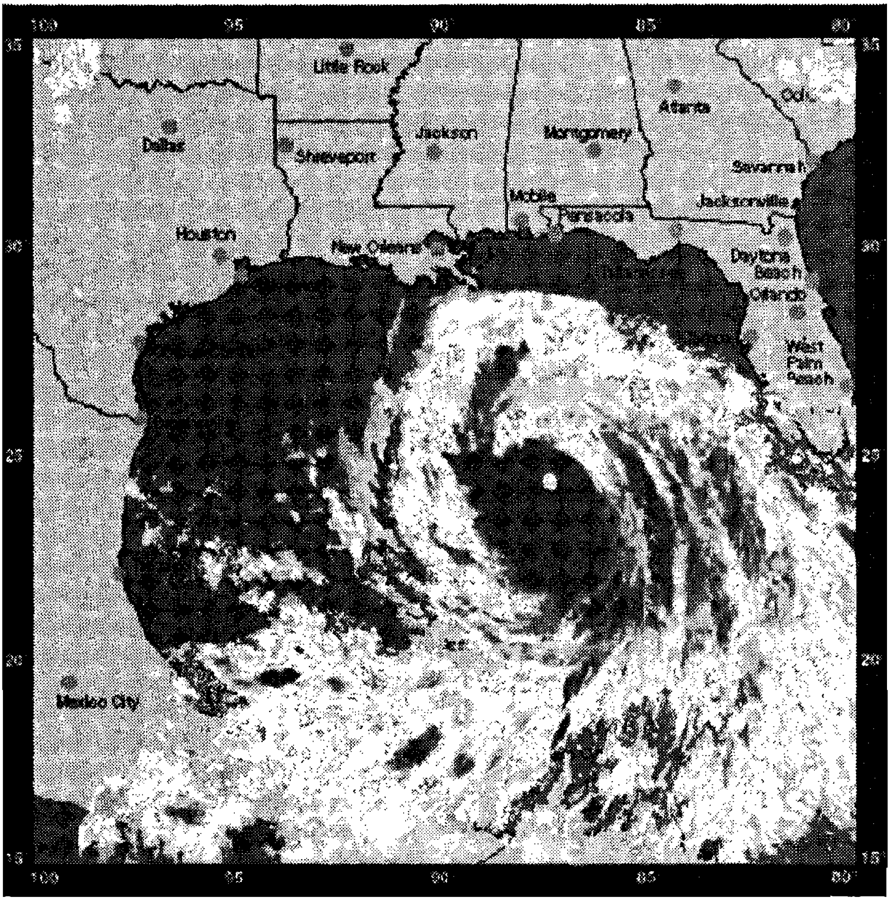


Table 1. Sample characteristics. Respondents who completed the survey were predominantly female, from Florida, between the ages of 20-21 and Communications majors.

Sex	**Male**	**Female**
	37.6% (77)	62.4% (128)

Home state	**Florida**	**Northeast**	**Southeast U.S.** (Not including FL)	**Other U.S.**	**Non-U.S.**
	81.6% (169)	7.2% (15)	4.3% (9)	4.3% (9)	1.4% (3)

Major (coded)	**Communications**	**Social Science**	**Business**	**Physical/Natural Sciences**	**Other**
	38.6% (80)	23.2% (48)	13% (27)	5.3% (11)	18.2% (37)

Age	**18-19**	**20-21**	**22-23**	**24 and over**
	26.1% (54)	45.9% (95)	15.5% (32)	12.3% (23)

Class Experience	**Map Reading**	**Map Making**	**Hazards**	**Other Weather Class**
	51.7% yes (107)	14% yes (29)	29.5% yes (61)	35.7% yes (74)

tion-seeking habits, and prior class experience in weather, natural hazards or map making/reading.

Survey Results

Sample Characteristics

Of the 254 students who gave their permission to take part in the project, 210 actually completed the survey, of which 207 were used. Three were discarded because they appeared to be duplicates. Of those respondents completing the survey who answered the question, 62.4% (128) were female and 37.6% (77) were male (See Table

Table 2. Viewing behavior. The table shows how frequently respondents view weather on television and where they get most of their weather information.

I watch the Weather Channel...

Always	Often	Sometimes	Rarely	Never
10.6% (22)	32.4% (67)	30.4% (63)	20.3% (42)	4.8% (10)

I watch the weather segment of my local news...

Always	Often	Sometimes	Rarely	Never
14% (29)	37.7% (78)	27.5% (57)	10.1% (21)	9.3% (19)

I get much of my weather information from...(percent replying "yes")

Weather Channel	TV News	Internet	Friends & Family	Radio	Newspaper	Other
70.5% (146)	65.7% (136)	45.4% (94)	48.8% (101)	38.2% (79)	23.7% (49)	6.3% (13)

Viewed the following during other tropical events...(percent replying "yes")

Weather Channel	Local Television News
On average 67.5% or 140 per storm	On average 68.4% or 142 per storm

1). An overwhelming majority (81.6%) called Florida their "home state," although twenty-two states, one territory and two foreign countries were represented, and a majority majored in either a social science field (23.2%) or communications field (38.6%).[3] The mean age of respondents was 21.3 years old (standard deviation, 4.09) with a range of 18 to 57. 83.6% (173) of respondents were 22 years old or younger. Additionally, many students had taken classes in one of the subject areas listed above (e.g. map reading, 51.7%).

A plurality of respondents (37.7%) watched local television weather "often" or "sometimes" (27.5%), and watched the *Weather Channel* "often" (32.4%) or "sometimes" (30.4%) (See Table 2). The most common source of information about weather for respondents was the *Weather Channel* with 70.5% replying "yes" they watched the *Weather Channel.* Local television news was viewed by 65.7%. During the actual events (Hurricane Gordon, Tropical Storm Helene, and other storms the respondent may have experienced) most respondents (from 64.7% to 73.4%) reported viewing local television news and the *Weather Channel*. Respondents were not asked whether they would view television news or the *Weather Channel* during the hypothetical event.

Reliability Analysis

Nine items attempted to measure the respondents' weather "attentiveness." Attentiveness was a construct operationalized as the sum of five of the attitudinal variables (interested in weather, informed about weather, considers weather daily, considers weather when making future plans, and fascinated with hurricanes), which were chosen through a reliability analysis using Cronbach's alpha (alpha = .6806). These questions dealt with the importance that students placed on weather knowledge, and an interest in hurricanes.

Six items were also combined using Cronbach's alpha for each of the four survey types (alpha = .8877, .8877, .8145, and .7991 for survey a through d respectively) to create the new variable *threat perception*. These six items relating to the perceived characteristics of the hurricane were intensity, damage potential, impact on oneself, impact on the coast, probability of landfall, and concern. Finally, this same technique was used to select the four most appropriate descriptors for the image students received. From the list of nine words, "bothersome," "horrible," "scary" and "worrisome" had the highest alpha values for survey types a through d (alpha = .7637, .7851, .8430 and .5519 respectively). These four descriptors were thus combined to create the new variable *negative description*.

Analysis of Variance

Prior to the analysis of variance, it became clear that the initial two hypotheses, which dealt primarily with the first variable *threat perception*, needed to be expanded to account for the addition of the second variable *negative description*. Since these two variables would remain distinct throughout the remainder of the analysis, the initial hypotheses were rewritten as follows.

Hypothesis 1a. Color enhanced images will be perceived as significantly more threatening than unenhanced visible images.
Hypothesis 1b. Color enhanced images will be described significantly more negatively than unenhanced visible images.
Hypothesis 2a. The category four hurricane will be perceived as significantly more threatening than the category two hurricane.
And
Hypothesis 2b. The category four hurricane will be described significantly more negatively than the category two hurricane.

Analysis of variance was then utilized to determine if the strength of the hurricane (category two or four) and the type of image received (enhanced IR or unenhanced visible) led to the same amount of threat perceived and the same level of negative description. This analysis used the new variables *threat perception* and *negative description*. The results of these tests indicated that those students receiving category four hurricane information perceived significantly more threat than those receiving category two hurricane information ($F_{1, 201} = 46.29$, $p = .000$). Similarly, those receiving category four hurricane information described the images significantly more negatively than those receiving a category two hurricane ($F_{1, 203} = 11.01$, $p = .001$).

The difference in perceived threat between those who received color-enhanced IR images and those who received unenhanced visible images approached significance ($F_{1, 201} = 3.11$, $p = .079$). No significant difference was found, however, between IR and visible images in terms of being negatively described ($F_{1, 203} = .176$, $p > .1$). The category four IR image was described significantly more negatively than both of the category two images ($F_{3, 201} = 3.91$, $p = .01$). The category by image by threat perception analysis mirrored the category by threat analysis. In other words, no significant difference was found in category by image, but significant difference was found in both images per category ($F_{3, 199} = 16.78$, p

= .000).

A covariance analysis was run to determine if the attitudinal factor attentiveness had any influence on responses on threat perception or negative description. When controlling for attentiveness, however, all results remained the same. Thus, while attentiveness may have some influence on perception of threat and negative description, it is not statistically significant.

Discussion

Hypothesis 1a proposed that color enhanced images would be perceived as more threatening than unenhanced visible images. The analysis was performed using the constructed variable, threat perception, to determine whether this was the case. The analysis suggested that due to factors associated with the placement and use of colors in the image as discussed previously, a color enhanced IR image would be perceived as more threatening than a similar un-enhanced visible image. While the color-enhanced image was perceived as more threatening, it was not described more negatively. Hypothesis 1b was not confirmed. A significant difference was not detected between images received in their negative description. A possible explanation for this lies in the selection of the nine descriptors. The focus group discussion provided the basis for selection of these descriptors. Other words might have been more appropriate for the images they were meant to describe.

Hypothesis 2a stated that the category four hurricane should be perceived as more threatening than the category two hurricane. The analysis of variance confirmed this hypothesis regarding the influence of strength of the hazard on the amount of threat perceived. One would expect this to be the case. Hypothesis 2b was also confirmed. The analysis suggested that category four hurricanes were also described significantly more negatively than category two hurricanes, confounding the earlier suggestion that selection of descriptor was inappropriate. See Table 3 for a summary of hypotheses and results.

Given the results of the focus group discussions, a final non-directional research question was raised to determine whether respon-

Table 3. The four hypotheses and their test results.

	Description	Status	F (degrees of freedom)	*p*-value
Hypothesis 1a	IR perceived more threatening	Inconclusive	$3.11_{(1, 201)}$	.079
Hypothesis 1b	IR described more negatively	Not Confirmed	$.176_{(1, 203)}$	.675
Hypothesis 2a	Category 4 more threatening	Confirmed	$46.29_{(1, 201)}$	.000
Hypothesis 2b	Category 4 described more negatively	Confirmed	$11.01_{(1, 203)}$	.001

dents' levels of attentiveness had an influence on their perception of the hurricane. The results of the analysis suggest that it did not. The fact that attentiveness was not found to influence the amount of threat perceived or the negative description of the images could demonstrate that one's rating of the importance of weather information in general does not apply during cases of severe weather. During such events, attentiveness is likely to be already heightened. Several respondents in the focus group, who would have been described as weather non-attentive, discussed the desire to view severe weather as an event. Perhaps a more adequate measure of attitude could have been devised to take this desire into account. It is also possible that a more appropriate attitude to measure would have been the predisposition to feel threatened in less intense situations. In future research, this variable should be considered.

A major limitation to this study, which may have impacted the results, was the use of students as the respondents. Students might not be the best indicator of public perception of hurricanes. As a group, students do not own property and would not have the same decisions to make during a hurricane. The researcher was surprised at the number of students who did view television news or the *Weather Channel* during the tropical storm and hurricane situations in the survey. She also feels that this number would be higher among the general population in the region for a number of reasons. Firstly, people with more to lose in severe weather situations should have a greater desire to seek information about how they or their property might be affected since the relevance for this group is greater. Secondly, the average age of respondents to this survey was 21.3 years. The average age of the television news viewer is considerably older than 21. In future research on this topic, a random sample of the population affected by hurricanes should be obtained.

While the use of students was a limitation in this study, there is no reason to believe that the general public would be less influenced by image type or hurricane category. Just over half the students who responded to the survey had taken a map-reading class in the past. This may have been an advantage in interpreting the image for a handful of the respondents. So, while the public may have more experience with television news and weather, that experience does not automatically suggest that they better understand the images they view on television.

Other questions may be raised by this research. One may wonder, for instance, whether the effect of the color enhancement on threat perception is significant enough to stimulate some behavioral response. In this study, it did not. Respondents receiving the enhanced image were not significantly more likely to leave their homes (t_{205} = 1.25, $p > .1$), leave the area (t_{205} = -.90, $p > .1$), or even make other preparations (t_{205} = -1.08, $p > .1$). The category of the hurricane in the survey received did translate to differences in behavioral action taken in two of the three responses. While those receiving information about category four hurricanes were not significantly more likely to leave their homes (t_{205} = .60, $p > .1$), they were significantly more likely to leave the area (t_{205} = -4.17, $p = .000$). There is also suggestive evidence that the hurricane category in the survey led to differences in whether respondents would make other preparations (t_{205} = -1.93, $p = .06$).

Conclusions

This study did demonstrate the need to consider the influence that color enhancement has on weather images when these images are meant for public consumption. More research is needed to determine if this perception holds true for the general population. If color enhancement does make a hurricane appear more threatening, this fact has implications for risk communication. When action such as evacuation is encouraged, weather broadcasters should emphasize the danger of the hurricane by showing enhanced images (which many currently do). When action is to be discouraged, however, weather broadcasters should take the time to carefully explain what the colors in the image mean and show the visible image as well.

Gamson and Modigliani (1989, in Stallings, 1990) stated that the role of news organizations is neither trivial nor decisive in the social construction of risk. Television remains an important if not the major source of information for people about weather, and especially severe weather. As part of the weather segment of the news, or as a large part of weather updates on the *Weather Channel*, satellite images do play a role in shaping public perception of threat. While there a multitude of factors determine what actions individuals take during severe weather, one should take great care to understand the influence (however small) that satellite images have in shaping perception of the hazard.

Notes

1. This is not the original web address. As a result of the change in location, the survey is no longer operational. Respondents were directed to a screen on which they could click a button to take the survey. The respondents would not have seen that there were four types of surveys. This is not the original web address. As a result of the change in location, the survey is no longer operational. Respondents were directed to a screen on which they could click a button to take the survey. The respondents would not have seen that there were four types of surveys.
2. Part of the html script for the survey included a function that allowed each of the four survey types to be called up randomly without replacement until each type had been viewed. This process would then be repeated for as long as people continued to visit

the page. In this manner, a sample size evenly divisible by four would have yielded an equal distribution of each survey type had a survey been correctly completed each time the page was visited. In reality, the distribution was nearly equal with 54 correctly completed type *a* surveys, and 51 type *b*, *c*, and *d* surveys.

3. In this study, communications is considered a group separate from social sciences because it is a separate college at the university. Social science refers to majors belonging to the College of Social Sciences. The author has assigned no other meaning to this division.

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