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Is Anchoring on Estimates of Severity an Adaptive Heuristic?

Joy E. Losee

IS ANCHORING ON FORECASTS OF SEVERE WEATHER AN ADAPTIVE HEURISTIC?

by

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(Under the Direction of Karen Z. Naufel)

ABSTRACT

Decisions to either to prepare or not prepare for weather threats involve uncertainty. Uncertainty in decision making often involves the potential for making either a false positive (preparing for a storm that never arrives) or a false negative error (not preparing for a real storm). Error Management Theory (EMT; Haselton & Buss, 2000) posits that, depending on the uncertain context, people select a decision-making strategy that favors one error over the other. Related to weather, research has shown that people prefer a false positive, or an overestimation (Joslyn et al., 2011). Particularly, this overestimation appears when people receive severe information prior to making a judgment. Thus, the present study tested whether or not the quality of severity influenced people to select a bias towards a false positive error. In two studies, participants made judgments about Friday's weather after viewing nine different sequences of two forecasts (sunny, cloudy, or stormy) from early in the week (Study 1) or after viewing weather forecasts from Monday and Wednesday (Study 2). In both studies, participants tended to base their judgments on the second forecast. The interpretation of this pattern, however, differs between the two studies based on anchor-type. In Study 1, bias toward the second forecast was the best available, least biased decision-making strategy. In Study 2, however, bias toward the second forecast was irrational because Wednesday's weather is not informative for Friday's weather. Thus, Study 2 demonstrated an anchoring-like bias.

INDEX WORDS: Decision-making, heuristics, anchoring

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When faced with the threat of severe weather, such as a hurricane or severe storm, an individual must decide to either prepare or not prepare. Implicit in this choice is a potential for making costly decision errors where taking action was not necessary or, alternatively, where choosing to not take action means paying the costs of the resulting damage. Understanding how a person weighs the costs and benefits of making this decision may provide insight on why people tend to underprepare for severe weather (Miller, Adame, & Moore, 2012). Additionally, understanding threat perception is important because it is the first step in deciding to prepare for a storm (Rogers, 1975; Lindell & Perry, 2012; Mulilis & Duval, 1995). Therefore, in order to increase preparedness in individuals under the threat of property damage or loss of life, it is key to identify the role that heuristic-based decision making plays under a weather threat.

Furthermore, understanding this decision making process will inform how to disseminate risk information in a way that encourages a person to recognize the cost of not preparing. Issuing weather warnings can be the most important factor in reducing loss when warnings are timely and it can also be a great cause of loss when warnings are not appropriately timed (Lee, Meyer, & Bradlow, 2009; Doswell, Moller, & Brooks, 1999). The present research took an evolutionary perspective to examining this problem. That is, the present research applied error management theory (Haselton & Buss, 2000) to predict how people process information about a threat in relation to their perception of the costs and benefits of choosing to prepare or not to prepare.

Error Management Theory

Error management theory (EMT; Haselton & Buss, 2000) predicts how judgment and decision-making biases are used as they relate to differing weights of costs and benefits to the decision maker. This theory is rooted in the principles of evolution where the costs and benefits relate to strategies for optimal reproduction and survival (Haselton & Buss, 2000). Specifically, EMT predicts that judgments and decisions under uncertainty favor preserving the maximum benefit while paying the minimum cost to reproduction and survival. Judgments and decisions in uncertain situations, if incorrect or erroneous, have the potential of being either false positive or false negative (Haselton & Buss, 2000). As Haselton and Buss pointed out, decreasing the likelihood of false positive error means increasing the likelihood of a false negative error and both cannot be minimized simultaneously. Therefore, bias toward one error over the other emerges. For example, people are more likely to make the error that a stick they are seeing out of the corner of their eye is a snake and reflexively jump away from the stick (Ohman & Mineka, 2003). In reducing the likelihood of a false negative (perceiving a stick when the stick is actually a snake) a person increases the likelihood of a false positive (perceiving a snake and wastefully expending the energy to jump away from a stick).

Originally, EMT was applied to the uncertainty of information inherent in the inferences one makes about the sexual interest of another, a circumstance affecting reproduction. Haselton and Buss (2000) found in their study that men tended to overestimate the sexual interest of women and that women tended to underestimate the sexual interest of men. EMT posits that this difference is due to an asymmetry in costs for men and women. For a man, his underestimation of sexual interest of a woman means missing a sexual opportunity. For a woman, her overestimation of sexual interest of a man means potentially carrying the offspring of a mate that did not intend to commit. EMT maintains that men have evolved to overestimate the intentions of women, favoring a false positive because it is more adaptively beneficial for them to seek an opportunity with a woman and be rejected than to miss an opportunity all together. Alternatively, women have evolved to underestimate the intentions of men, favoring a false negative because it is much more costly for them to pursue the sexual interest of a mate that will not commit and help them care for their young. To support EMT, this same pattern of decisions and judgments weighted by asymmetrical costs and benefits exists in other studies on mating and relationships (Howell, Etchells, & Penton-Voak, 2012; Haselton, 2003; Cyrus, Schwarz, & Hassebrauck, 2011). For example, men who rated themselves as more likely to engage is short-term casual sexual relationships judged faces of smiling women as more flirtatious than those men who were not so inclined to these types of relationships (Howell et al., 2012). This pattern suggests that men likely to engage in short-term casual sexual relationships favor making a false positive error when judging the flirtatiousness, or sexual interest, of a woman in a picture. Similarly, when people self-reported how many times someone misjudged their sexual interest, women more than men reported experiences with false-positive errors, where a man assumed they were interested when they were not (Haselton, 2003). Furthermore, this sexual under-perception bias did not replicate when tested with postmenopausal women (Cyrus et al., 2011). The authors explain this effect by noting that postmenopausal women could no longer produce children; therefore, these women were not concerned with whether or not their sexual partner was committed and would help care for their offspring (Cyrus et al., 2011).

Although many applications of EMT deal with judgments and decisions regarding reproduction (Howell et al., 2012; Haselton, 2003; Cyrus et al., 2011), patterns of EMT have also been observed in situations where biases would have been naturally selected for their benefit to survival, such as disease avoidance (Kouznetsova, Stevenson, Oaten, & Case, 2011; Park, Van Leeuwen, & Chochorelou, 2013; Miller & Manner, 2012). For example, people self-reported more discomfort in experiencing close physical contact with people described as having visible disease compared to those who did not have visible disease even if the visible disease was not contagious (Kouznetsova et al., 2011). In this example, participants preferred to forgo any benefit of contact with the non-contagious visibly ill person to avoid the risk of catching the disease, which indicates a preference for a false positive. Similarly, people reported experiencing more discomfort when they thought about physical contact with people with visible disease (e.g., leprosy) and visible atypical morphologies (e.g., amputation) compared to reporting discomfort when they thought about physical and nonphysical contact with those described as criminals (Park et al., 2013). Taken together, these studies emphasize the preference for one cost (missed social interaction with someone who was not contagious) over another (being infected by someone who was indeed contagious).

The *behavioral immune system* may explain these false positive errors. Miller and Maner (2012) propose that in the same way that the physiological immune system is subject to allergies, or overreactions to potential pathogens (false positive error), the behavioral immune system can over react to prevent disease through contact. They maintain that these “allergies” are cognitive disease-avoiding biases that favor false positive errors and rely on heuristic disease cues, or cues that are representative of the category “disease” (e.g, acne, rashes, or obesity). Supporting their theory, these researchers found that both a high level of trait perceived disease vulnerability and state perceived disease vulnerability lead to changes in cognitive measures of categorization and memory. Similarly, they found that increased perceived disease vulnerability (trait and state) lead to a higher likelihood that participants over-remembered previously seeing a picture of an obese individual and over-categorized pictures of obese individuals compared to pictures of accidental damage. These authors argued that the behavioral immune system errs on the side of caution, preferring to attend more to the heuristic disease cue of obesity and those that are representative of disease. Additionally, they argue that the behavioral immune system has been refined across the generations, being passed along by those with strong behavioral immune systems. In this case, the costs to the individual as a result of judgment error is paying too much attention to an individual that was not contagious (preferred cost) compared to not paying attention to those who pose a threat and then being infected.

Indeed, evolution maintains that people inherit traits from those ancestors that were successful at surviving and reproducing, therefore, their successful traits are passed from generation to generation (Darwin, 1859). EMT thus posits that specific cognitive biases favoring the greatest benefit at the least cost have been passed and refined along the generations to be employed when the organism is situated under uncertainty (Haselton & Buss, 2000). Weather information is not precise and involves uncertain probabilities and predictions. The cost of underestimating storm severity is potential death or injury. The cost of overestimating storm severity is spending the time, money, effort, or all three for no reason. EMT predicts that people will tend to overestimate severity because the cost is directly related to survival. The anchoring heuristic is a cognitive bias that is potentially employed when making judgments about the uncertainty of weather.

Anchoring

The anchoring heuristic ("anchoring") is a bias that traditionally occurs when initial values imparted to the estimator before a judgment influences the judgment (Tyversky & Kahneman, 1974). For example, when people estimated the amount of states in the Union in 1880, they tended to overestimate if they are first made aware that there are currently 50 states in the Union and underestimate when they are first told that there were 13 original colonies (Epley & Gilovich, 2006). Anchoring has been shown to have an effect from environmental stimuli. For example, participants viewed a picture of a football player wearing a jersey with either the number "54" or "94" and then estimated the percent chance that the football player they read about would make a sack in the playoffs. Participants who viewed the picture of player “94” estimated a higher percentage than those who viewed the picture of player “54” (Critcher & Gilovich, 2008). In another experiment, participants agreed or disagreed to pay a price for product that was, unknown to them, based on the last two digits of their social security number (Ariely, Loewenstein, & Prelec, 2003). After this agreement procedure, participants stated the maximum amount they were willing to pay for the same good. People were willing to pay less after agreeing to the small amount than people who agreed to the larger amount. Ariely and consistently showed in their six experiments that participants’ response outcomes (e.g. willingness to listen to an annoying sound for a proposed amount of money) changed in the direction of the influence of such irrelevant high or low anchors. These effects of irrelevant environmental anchors have been demonstrated in across several studies (e.g., Wansink, Kent & Hoch, 1998; Mussweiler, Strack, & Pfeiffer, 2000).

Several theories suggest that anchoring results from semantic priming or activation of information that is consistent with the initial value (Furnham & Boo, 2011; Mussweiler & Strack, 1999). Specifically, the *selective accessibility theory* of anchoring suggests that anchoring serves as a confirmatory hypothesis test where evidence is sought in a biased manner to support or confirm a hypothesis (Mussweiler & Strack, 1999). The hypothesis is that the anchor is a plausible answer to the target question or estimate, and the adjustment away from the anchor is made by testing how similar the target could be to the estimate. Through this process, the decision maker is cognitively activating aspects of the target that are congruent with the initial value and anchoring occurs (Mussweiler & Strack).

Anchoring via the selective accessibility model has been tested primarily in traditional single anchor paradigms that show errors in judgment. However, selective accessibility theory still applies to an adaptive function of anchoring. For example, when a person is making a prediction about a weather event in the future, she will consider the ways in which this target judgment, the future weather judgment, is similar to the information included in a forecast. If the sequence of forecasts involves a qualitatively severe forecast, then anchoring may prime severity and function according to cost-benefit bias patterns of EMT (Haselton & Buss, 2000). Adaptively, the target judgment may seem more similar to a severe anchor, because according to EMT (Haselton & Buss, 2000), it is less costly to overestimate the severity of a future weather event.

Anchoring, Weather, and the Current Study

Anchoring has indeed been demonstrated in weather information research (Joslyn, et al., 2011; Losee, Naufel, Locker, in prep). However, anchoring has not occurred on the initial value, or warning, rather, the bias has been toward the most severe warning in the series. In Joslyn et al. (2011), participants issued a wind advisory warning and estimated the wind speed for the next day. Participants given the upper bound forecast that there is a "10% chance that the high wind speed will be greater than 27 knots" (p. 344) and a deterministic warning stating the expected wind speed for the next day, were more likely to issue the wind advisory and to estimate high wind speeds the next day. The group receiving upper bound forecasts made higher estimates compared to the group that only received information in the typical deterministic format, "the high wind speed will be 15 knots" or the group that received the typical information and information about the lower bound prediction that there is a "10% chance that high wind speed will be lower than 3 knots". These results confirm that anchoring effects were observed when the upper bound information indicated a severe wind speed.

This effect was replicated where, over repeated trials, participants decided whether or not to ice roads based on the three different types of information. In this scenario, participants who received lower bound information (i.e., a 10% chance that the overnight low will be lower than 32 degrees (p. 344)) tended to ice roads and judged that the overnight low would be significantly lower than the judgments of the other groups. Together, these studies indicate that it is not the upper bound or lower bound information that leads to biases; it is the severity of the estimate. The upper bound wind speed was severe, just like the lower bound over night temperature was severe (Joslyn et al., 2011). The bound on which participants anchored changed as a function of the severity of the bound. These results do not follow traditional ideas about anchoring (Tversky & Kahneman, 1974; Epley & Gilovich, 2006) because the type of anchoring changed based on a quality of the anchor, not the initial value. Traditional anchoring did not occur for each format of weather warning, only for the warnings that indicated severity. Thus, anchoring when presented with a severe estimate suggests that there may be a survival mechanism in the form of a cognitive bias that underlies the information processing of weather messages.

The effect that Joslyn et al. (2011) observed was replicated in a line of research that tested anchoring on a series of hurricane warnings (Losee, Naufel, & Locker, in prep). In three studies, participants saw two weather warnings for the same hurricane. The warnings were either high or low in severity, creating a four-groups design where participants either saw both Category 1 warnings, both Category 5 warnings, a Category 1 and then Category 5 warning, or a Category 5 then a Category 1 warning. The participants then estimated the hurricane's expected damage and reported intentions to prepare. Consistent with EMT and the evolutionary idea of the passing of successful survival traits, participants reported more expected damage and greater intentions to prepare after viewing high severity warnings compared to only viewing low severity warnings. In the last study, participants saw four weather warnings about the same hurricane. The warnings varied in five ways as to which position the one high severity warning was located within the four warning series (e.g., Category 1, Category 1, Category 5, and Category 1). Consistent with previous studies, estimates of likelihood of damage were higher for the condition where the severe warning appeared last. More importantly, however, estimates were just as high for the conditions where the severe warning was first, second, or third. Again, participants anchored on the severe warning and based their judgments on the implications of that warning's severity.

These studies connecting anchoring and weather suggest that bias in weather information processing changes in relation to content of the warnings rather than the initial weather warning. The manifestation of anchoring to severe weather forecasts as opposed to the initial value may actually have developed because it is adaptive, and it is adaptive in that it allows us to make the best possible decision when all of the information about a situation is unknown (Haselton & Nettle, 2006; Gigerenzer, 2008). Although the anchoring bias tends to be synonymous with error (Tversky & Kahneman, 1974; Mussweiler & Strack, 1999; Furnham & Boo, 2011; Epley & Gilovich, 2006; Critcher & Gilovich, 2008), bias, in general, may actually have an adaptive function in certain specific contexts where bias is toward certain errors because these errors are less costly than others (Haselton & Buss, 2000).

Assumptions of EMT's adaptive, albeit biased cost analysis are built on the premise that cognitive mechanisms (e.g. the biased information processing mechanisms that favor risk of one error over another) are modular, domain-specific, and content-dependent as opposed to domain-general and content-independent. Domain-specific cognitive mechanisms are like cognitive units--each unit is refined through natural selection because it was used to process information in a specific environment under a specific set of circumstances (Cosmides, 1989). This concept of specialization of cognitive mechanisms is contrary to the idea widely accepted, but relatively unsuccessfully predicted (Cosmides, 1989), that mechanisms are domain-general and that there are a few simplifying heuristics employed under general uncertainty. Indeed, Jackowitz and Kahneman (1995) and Epley and Gilovich (2001) argue that there are varieties of anchoring effects suggesting that there may not be a single general mechanism. For example, Jackowitz and Kahneman showed different anchoring effects depending on whether the anchor was high or low.

In the present study, the anchors will differ on a level of severity. EMT provides an explanatory framework for why different judgment errors emerge about the same subject by different people, or in different contexts. To understand a cognitive mechanism, one must look at the problem or environment that the forces of natural selection adapted the mechanism to function for rather than assessing the mechanism as an isolated phenomenon (Cosmides & Tooby, 2013; Gigerenzer, 2008). From this viewpoint, Gigerenzer points out that researchers should determine the environments where a cognitive mechanism succeeds and where the mechanism fails. As such, the present research asked, in what contexts does weather risk information processing succeed and in what contexts does it fail? Studies have shown anchoring effects of the most severe forecast on weather information processing in a series (Losee et al., in prep). These studies did not, however, test a condition in which anchoring as it traditionally functions (estimation based on an initial value; Tversky & Kahneman, 1974) occurs with non severe weather information. The present research further examines the anchoring on severity pattern by testing it as an adaptation as opposed to a simple erroneous heuristic process.

The Present Studies

Given that the timing of weather warnings is important for perceiving risk (Lee et al., 2009; Brooks et al., 1999) and that risk perception is the first step in becoming motivated to protect oneself (PMT; Rogers, 1975; PADM; Lindell & Perry, 2012; Mulilis, 1995), it is important to understand the risk perception process. Part of this consideration involves processing uncertainty because people must rely on heuristics and biased cognition (Gigerenzer, 2008). When processing information that deals with survival or reproduction, people favor the least costly error (Haselton & Buss, 2000; Haselton & Nettle, 2006). Indeed, it has been documented that, in conditions of threat (e.g. disease avoidance and weather), false negatives tend to be avoided while false positives are favored (Koutznetsova et al., 2011; Miller & Maner, 2012; Cyrus et al., 2013; Joslyn et al., 2011; Losee et al., in prep). In the case of weather, a false positive error results in paying the costs of being prepared for a storm that never arrived. Conversely, a false negative error means experiencing costly harm and loss because of under-preparedness for a storm that did make landfall. EMT predicts, then, that people would prefer the costs associated with a false positive, preparation for a nonexistent storm.

Therefore, if the anchoring effects found in judgments about weather were due to an adaptive, overestimation function of the anchoring heuristic, then I expected anchoring to function adaptively when severity information is imparted to a participant and that anchoring would function more erroneously when a participant was making estimates about a non-severe set of weather information.

The present two studies directly tested the content of severity in a forecast as an influence of later predictions and judgments about a single event. The first study tested nine different series of two weather forecasts that differed in content such that some of the series included a forecast of severe weather (stormy) or non-severe weather (cloudy or sunny) that varied in position either first or last. Participants imagined they were a party planner that must decide each week whether or not to cancel a pool party. They were instructed to only cancel the pool party if they thought that there would be a safety risk. Bias in weather prediction and decision to throw the party was based on the cost and benefits associated with that weather forecast. I expected that if people favored making predictions that preserved safety (predicted by EMT; Haselton & Buss, 2000), hence overestimating risk in the face of severe weather information, then anchoring effects would occur in their subsequent predictions biased towards increased severity perception regardless of whether the series of predictions indicate that the weather should weaken in severity. This bias demonstrates a preference for the cost of cancelling the party when no storm occurs (false positive) over the cost of holding the party and having it in the middle of a storm (false negative).

Additionally, I expected that if severity is the content that causes people to make judgments biased towards higher risk perception and preference for false positive errors, then predictions based on series of forecasts that include no severity information should lead to an anchoring error where participant predictions would be heavily oriented toward the first warning where costs and benefits were irrelevant (predicted by Tyversky & Kahneman, 1974). Differences were tested within-subjects to further preserve ecological validity as an individual is likely to process forecasts of varying severity in daily life (Greenwald, 1976). Furthermore, although the difference in anchoring severity perception on the most severe information has been shown between-subjects (Joslyn et al., 2011; Losee et al., in prep), the within-subjects design was a better test of an adaptation. This increased ability to assess an adaptation within-subjects is because of domain-specificity, which suggests that it is the context that influences the selection of an cognitive processing strategy and thus, these changes should be evident in an individual's performance.

The second experiment sought to add to the findings of experiment one by providing further evidence that the effect is indeed were due to the prior influence of only severity information by changing the judgment task to assessing Friday's weather based on Monday and Wednesday's actual weather with the same sunny, cloudy, stormy manipulations, thus making the anchors even less relevant. Although meteorologists calculate forecasts based on current conditions, meaning that the actual weather of Monday and Wednesday would be used to calculate the forecasts for Friday (Study 2), these weather forecasts alone are not as weighty for predicting Friday's weather as the actual Friday forecast that is computed on Monday and Wednesday (Study 1) (Wang, Sankarasubramania, & Ranjithan, 2013). Study 2's design was the same as Study 1's design with just the change to the day of weather information. Participants were expected to cancel the party and predict stormy weather when there was a stormy forecast for either Monday or Wednesday than when there were only combinations of sunny and cloudy weather forecasts. Alternatively, anchoring effects predicted by Tversky and Kahneman (1974) were expected such that people's predictions would be biased toward the initial information when severity information was not included in the sequence.

Experiment 1

Method

Participants

Twenty-nine Georgia Southern students participated in this study. These participants signed up on "SONA" Systems which is run by the Georgia Southern University Psychology department and allows college students in Psychology courses to participate in experiments and earn credit for their classes. Variation in age was minimal as Georgia Southern students tend to be traditional college students between the ages of 18 and 24. All participants were treated ethically in accordance with American Psychological Association Guidelines. Therefore, they were provided informed consent (Appendix A).

Design and Manipulation

In order to assess how content of a weather forecast influences the function of anchoring, participants viewed nine different series of two sequential weather forecasts. The forecasts were non-severe (cloudy and sunny) or severe (stormy). Forecasts varied by what type of forecast came first (sunny, cloudy or stormy) and what type of forecast came second (sunny, cloudy or stormy). Thus, the study employed a 9-group one-way repeated measures design. Due to the applied nature of this research, and in an effort to preserve ecological validity, the weather forecasts appeared similar to a local television weather forecast.

The weather forecasts were programmed into nine different videos in which the first forecast is sunny, cloudy or stormy and the second forecast was either sunny, cloudy, or stormy (see Appendix B1 for stimuli). The videos were programmed with combined audio and visual information to facilitate attention and salience of the stimuli (Ernst & Bulthoff, 2004).

Measures

To assess anchoring, participants made judgments regarding their weather prediction for Friday (adapted from Joslyn et al., 2011), the severity of the weather, and the danger of the weather. All judgments were made on a visual analog scale to assure that participants can make use of the full range of the scale (Hayes, Allen, Bennet, 2013; Appendix C). For the weather prediction item, numbers were analyzed such that predictions closest to sunny fell around 0, closest to cloudy fell around 50, and closest to stormy fell near 100. Participants could not see these numbers. For the severity and dangerousness judgments the low end was close to 0 and the high end was close to 100. Additionally, I assessed the extent that participants would cancel the pool party based on the previously seen weather forecasts. As with the other measures, this item was measured on a visual analogue scale with 0 being a low likelihood and 100 being a high likelihood. This judgment, particularly, was predicted to be influenced by the costs associated with a prediction for Friday's weather where a severe weather prediction would necessitate cancelling the pool party. This decision was expected because it meant avoiding the cost of putting people's safety at risk by swimming during a storm.

Procedure

A diagram of the procedure can be found in Appendix D. All experimenters followed a script (Appendix E). Participants were welcomed into the lab. The participant sat at a computer where the computer has the informed consent page of the experiment displayed. After explaining the informed consent, the experimenter asked the participant to click "Yes, I would like to participate" on this screen. After indicating their consent, the experimenter instructed the participants to put on the headphones (so that they could hear the forecasts) and to carefully read the instructions on the page following the informed consent.

Then, participants engaged in practice trials. The first three videos were not series of forecasts. Rather, the videos were counterbalanced single-forecasts (sunny, cloudy, stormy) where participants estimated, directly following each video, their safety risk given the forecast. This procedure was used as a pretest manipulation check to assure that if anchoring occurs on the stormy warning, regardless of its position, it was because participants perceived severity from the stormy forecast (Perdue & Summers, 1986). Participants also answered a question where they indicated which type of weather (sunny, cloudy, stormy) poses a safety risk as an additional manipulation check to assure that participants understood that the only forecast that poses a safety risk this the stormy forecast.

Following the practice trials, participants read this scenario (adapted from Joslyn, Savelli, Nadav-Greenberg, 2011):

> "Weather forecasters base their predictions on computer models that tell them *likelihood* of a given weather event. The statement in the forecasts is the information from the computer model. Your job is to play the role of a party planner at a pool venue. It is summertime and each Friday, the pool is reserved for a party. It is your responsibility to watch weather forecasts throughout the week. Based on the likelihood of weather you must decide each weekend to set-up poolside for the party, or, in the case of bad weather, reschedule the party. It is very important to cancel a pool party if there is severe weather because it puts people's safety at risk. It is also very important to *only* cancel the pool party if there is a safety risk because people will stop booking parties at your venue if you reschedule parties too often."

Following, participants viewed one set of the stimuli. The first video began with a slide that says "It is early in the week and you are checking the forecast for Friday." Following this wording, the participant saw the forecast for Friday. Next, the video had a slide that says "Later in the week, you are checking the forecast for Friday." The video ended, and the participant was presented with four visual analog scales. Because the context of a question can shape subsequent answers (Schwartz, 1999), each scale was on a separate page to avoid order effects of seeing answers on one scale before answering on another scale. Following the first video, the participant saw the following instructions:

"First, indicate what you think the weather will be on Friday on the prediction on a scale of Sunny to Cloudy to Stormy, by dragging the bar on the scale. For instance, if you think it is likely to be Sunny you would drag the bar to the LEFT end of the scale. If you think it is likely to be Stormy you would drag the bar to the RIGHT end of the scale."

Instructions for the next three questions regarding severity, dangerousness, and decision to hold the party were the same (Appendix C). This procedure of viewing videos and making responses on the visual analog scales was completed for each of the nine conditions. The nine conditions were counterbalanced for each participant. To avoid the risks of carry-over effects using repeated measures, the videos were also counterbalanced (Greenwald, 1976). Demographic information was not collected for this study. The slider on the visual analogue scale had a default position on the "0" end. Thus if participants did not want to adjust the scale, they would leave it as is, but it would not record of Qualtrics. After realizing this was a problem, I included a statement about "locking in" responses in the instructions before starting the experiment.

Results and Discussion

I analyzed the effect of all nine levels of the within-subjects factor (order of sunny, cloudy, and stormy videos either first or last) on each measure with separate One-Way Repeated Measures Analyses of Variance (ANOVAs). I removed four subjects from analyses because of either a programming error in the presentation of the videos, such that they did not see one of the videos (1 participant) or if the experimenter noticed that the participant skipped through videos (3 participants). Additional variations in degrees of freedom are due to missing data.

Manipulation Check

A one-way repeated measures ANOVA revealed a main effect of forecasts type on perception of risk of the individual forecast, F (2, 38) = 82.22, $p < 0.05$, $\eta_p^2 = .81$. Four comparisons were submitted to post hoc testing using Bonferroni adjusted alpha levels of $p <$ .013 (.05/4) such that risk for a sunny (M = 2.55, SEM = .68) was lower than risk for cloudy (M = 35.65, SEM = 5.71) ($p < .05$) and stormy (M = 78.15, SEM = 6.23) ($p < .001$), and that cloudy was lower than stormy ($p < .001$).

Primary Measures

For the measure of weather prediction, I included the data from 18 participants. Mauchley's test indicated that the assumption of sphericity had been violated χ^2 (35) = 154.49, $p < .001$. Using the Greenhouse-Geisser correction, analyses revealed a main effect of video type on weather prediction on the visual analogue scale, F(2.4, 40.85) = 189.26.81, $p < 0.05$, $\eta_p^2 =$ .92. Thirty-five comparisons were submitted to post hoc testing using Bonferroni adjusted alpha levels of .001 per comparison ($p < 0.05/35$). Tests revealed significant differences between levels of the within-subjects factor of video type (see Table 1 for means). Participants made different judgments after watching either the sunny, cloudy or stormy forecasts second and the sunny forecast first. Similarly, participants made different judgments after watching the sunny, cloudy, or stormy forecasts second and the cloudy forecast first. The same pattern emerged after for all stormy first sequences. Additionally, participants made predictions closest to the cloudy mark when they saw the cloudy forecast second regardless of which forecast they saw first. Also, participants made predictions closest to the stormy mark when they saw the stormy forecast second regardless of what they saw first. Additionally, when participants saw the stormy forecast second and the sunny forecast first they marked further away from the sunny mark compared to when they saw the sunny forecast first and second. Additionally, people adjusted the scale the least overall after watching the sunny forecast first and second.

For the measure of prediction of severity of weather on Friday, I included the data from 14 participants. Mauchley's test indicated that the assumption of sphericity had been violated χ^2 (35) = 104.52, $p < .001$. Using the Greenhouse-Geisser correction, analyses revealed a main effect of video type on weather prediction on the visual analogue scale, $F(3.01, 39.13) = 170.79$, $p < 0.05$, $\eta_p^2 = .92$. 35 comparisons were submitted to post hoc testing using Bonferroni adjusted alpha levels of .001 per comparison ($p < 0.05/35$). Tests revealed significant differences between levels of the within-subjects factor of video type (See Table 2 for means). Participants estimated different levels of severity after watching either the sunny (lowest), cloudy or stormy (highest) forecasts second and the sunny forecast first. Similarly, participants estimated different levels of severity after watching the sunny (lowest), cloudy, or stormy (highest) forecasts second and the cloudy forecast first. The same pattern emerged after for all stormy first sequences. Participants had similar estimates of low severity after viewing the sunny forecast second regardless of which forecast they saw first. They estimated severity to be lower after viewing cloudy second and sunny first compared to viewing cloudy second and stormy first. Additionally, they estimated severity to be lower when they viewed the stormy forecast second and the sunny forecast first compared to the stormy forecast first and second.

For measures of prediction of dangerousness of weather on Friday, I included data from 17 participants. Mauchley's test indicated that the assumption of sphericity had been violated χ^2

(35) = 87.49, $p < .001$. Using the Greenhouse-Geisser correction, analyses revealed a main effect of video type on weather prediction on the visual analogue scale, $F(3.51, 56.18) = 202.60$, $p < 0.05$, $\eta_p^2 = .93$. 35 comparisons were submitted to post hoc testing using Bonferroni adjusted alpha levels of .001 per comparison ($p < 0.05/35$). Tests revealed significant differences between levels of the within-subjects factor of video type (See Table 3 for means). Participants estimated different levels of dangerousness after watching either the sunny (lowest), cloudy or stormy (highest) forecasts second and the sunny forecast first. Similarly, participants estimated different levels of dangerousness after watching the sunny (lowest), cloudy, or stormy (highest) forecasts second and the cloudy forecast first. The same pattern emerged after for all stormy first sequences. Participants estimated dangerousness lower when they saw the sunny forecast second regardless of what they saw first compared to when they saw the stormy forecast second regardless of what they saw first. Additionally, when participants saw the stormy forecast second and the sunny forecast first they estimated higher dangerousness compared to when they saw the sunny forecast first and second.

Finally, for the measure of likelihood to throw the pool party, I included data from 13 participants. Mauchley's test indicated that the assumption of sphericity had been violated χ^2 (35) = 92.19, $p < .001$. Using the Greenhouse-Geisser correction, analyses revealed a main effect of video type on weather prediction on the visual analogue scale, F (2.71, 35.57) = 78.06, $p < 0.05$, $\eta_p^2 = .87$. 35 comparisons were submitted to post hoc testing using Bonferroni adjusted alpha levels of .001 per comparison ($p < 0.05/35$). Tests revealed significant differences between levels of the within-subjects factor of video type (See Table 4 for means). Participants judged different levels of likeliness to throw the pool party after seeing the sunny (lowest), cloudy, or stormy (highest) forecasts second and the cloudy forecast first. This same pattern emerged in participants' judgments after viewing sunny, cloudy, or stormy second and the stormy forecast first. Participants were more likely to throw the pool party after seeing the sunny forecast second regardless of what they saw first compared to after seeing the stormy forecast second regardless of what they saw first.

It is important to note that analysis of the manipulation check indicated that cloudy was not a true "non-severe" forecast because participants rated this forecast as more risky than a sunny forecast. However, participants did rate the stormy forecast as more risky than the cloudy forecast. Generally, results from the four estimate measures suggest that the second forecast had more influential weight than the first forecast. However, results also suggest that, on some occasions (i.e., predicting the weather and estimating dangerousness), people overestimated the risk of severe weather when there was severe information in the forecast sequence compared to when there was non-severe information in the forecast sequence. For example, people rated higher dangerousness of Friday's weather after seeing the stormy forecast first and the sunny forecast second compared to after seeing the sunny forecast first and second. This pattern supports EMT-based anchoring because this difference is different from the general pattern of biasing judgments toward the second forecast. The results also suggest that when people are estimating severity, their estimations can be influenced by the first forecast. This pattern supports traditional anchoring because the influence of the first forecast demonstrates a primacy bias toward the first thing a person hears.

Study 1 provided a comparison of severe versus non-severe forecasts and their influence on people's estimates for a target day. However, Study 1 provided the participant with information that was rational to base judgments from- the second forecast. The second forecast is rational because the most recent forecast for a given day is, to that point, the most accurate estimate meteorologists have. Having the rational information available might explain why participants were more influenced by the second forecast more than the more severe forecast as predicted with EMT. Perhaps, in weather decision-making, people are able to determine what the rational forecast is, and thus, prefer to base their judgments on that information. To further isolate the influence of severity information on people's predictions and judgments about the weather, I conducted a second study that increased the irrelevance of the anchor changing the videos to weather forecasts from Monday and Wednesday earlier in the week.

Experiment 2

Method

Participants

Twenty-eight participants from Georgia Southern University participated in this study.

Design, Manipulation, and Measures

The design of this study was the same as the previous study. The manipulation was, however, different in the information videos that the videos contained. Participants viewed nine different series of two sequential weather forecasts. The forecasts were non-severe (Cloudy and Sunny) or severe (Stormy). The forecasts were first for Monday weather and second for Wednesday's weather (Appendix B2). Forecasts varied by what type of forecast came first (sunny, cloudy or stormy) and what type came second (sunny, cloudy or stormy). Thus, as with the first experiment, this study employed as a nine-group one-way analysis of variance. The measures and procedure were the same employed in Study 1 (Appendix C & D).

Results and Discussion

I analyzed the effect of all nine 9 levels of the within-subjects factor (order of sunny, cloudy, and stormy videos either first or last) on each measure with separate One-Way Repeated Measures Analyses of Variance (ANOVAs). As with Study 1, I removed four subjects from analyses because of either a programming error in the presentation of the videos, such that they did not see one of the videos (2 participants) or if the experimenter noticed that the participant skipped through videos (2 participants).

Manipulation Check

For the manipulation check, a one-way repeated measures ANOVA revealed a main effect of forecasts type on perception of risk of the forecast, F (2, 26) = 24.19, $p < 0.05$, η_p^2 =

.65. Four comparisons were submitted to post hoc testing using Bonferroni adjusted alpha levels of $p < .013$ (.05/4) such that risk for a sunny ($M = 11.86$, $SEM = 4.16$) was lower than risk for cloudy ($M = 33.07$, $SEM = 9.21$) and stormy ($M = 59.93$, $SEM = 7.18$) ($p < .001$), and that cloudy was lower than stormy ($p < .001$).

Primary Measures

For the measure of weather prediction, I included the data from 13 participants. Mauchley's test indicated that the assumption of sphericity had been violated χ^2 (35) = 62.03, $p = .006$. Using the Greenhouse-Geisser correction, analyses revealed a main effect of video type on weather prediction on the visual analogue scale, F (3.48, 41.75) = 15.24, $p < 0.05$, $\eta_p^2 = .56$. 35 comparisons were submitted to post hoc testing using Bonferroni adjusted alpha levels of .001 per comparison ($p < 0.05/35$). Tests revealed significant differences between levels of the within-subjects factor of video type (See Table 5 for means). Similar to Study 1, participants made predictions near the sunny mark when they viewed the sunny forecast for Wednesday regardless of which forecast they saw for Monday.   After seeing cloudy for Wednesday, people were more likely to predict cloudy for Wednesday regardless of what they saw for Monday. When participants saw the stormy forecast for Wednesday, their predictions fell closer to stormy, regardless of what forecast they saw for Monday. Additionally, when it was stormy on Monday and Wednesday, people expected that it was more likely for Friday to be stormy than when it was sunny on Monday and Wednesday. Participants also made similar predictions when they saw cloudy or stormy for Wednesday and sunny for Monday.

For the measure of prediction of severity of weather on Friday, I included the data from 15 participants. Mauchley's test indicated that the assumption of sphericity had been violated χ^2 (35) = 76.67, $p < .001$. Using the Greenhouse-Geisser correction, analyses revealed a main effect of video type on weather prediction on the visual analogue scale, F (3.80, 53.23) = 17.11, $p <$ 0.05, $\eta_p^2 = .55$. 35 comparisons were submitted to post hoc testing using Bonferroni adjusted alpha levels of .001 per comparison ($p < 0.05/35$). Tests revealed significant differences between levels of the within-subjects factor of video type (See Table 6 for means). Generally, mean differences in estimates of severity followed the same pattern as the prediction measure. For example, when participants saw a cloudy forecast or a stormy forecast for Wednesday and a sunny forecast for Monday, they judged similar levels of severity.

For the measure where participants predicted the dangerousness of weather on Friday, I included data from 16 participants. Mauchley's test indicated that the assumption of sphericity had been violated χ^2 (35) = 70.50, $p < .001$. Using the Greenhouse-Geisser correction, analyses revealed a main effect of video type on weather prediction on the visual analogue scale, F (3.58, 53.68) = 15.18, $p < 0.05$, $\eta_p^2 = .50$. 35 comparisons were submitted to post hoc testing using Bonferroni adjusted alpha levels of .001 per comparison ($p < 0.05/35$). Tests revealed significant differences between levels of the within-subjects factor of video type (See Table 7 for means). Again, the pattern of estimate differences on this measure, following each of the videos, was similar to the pattern of estimates differences on the previous two measures: The Wednesday forecast seemed to have more influence than the Monday forecast.

Finally, the measure of likelihood to throw the pool party, I included data from 18 participants. Mauchley's test indicated that the assumption of sphericity had been violated χ^2 (35) = 55.05, $p = .022$. Using the Greenhouse-Geisser correction, analyses revealed a main effect of video type on weather prediction on the visual analogue scale, $F(4.14, 70.33) = 15.15$, $p < 0.05$, $\eta_p^2 = .47$. Thirty-five comparisons were submitted to post hoc testing using Bonferroni adjusted alpha levels of .001 per comparison ($p < 0.05/35$). Tests revealed significant differences between levels of the within-subjects factor of video type (See Table 8 for means). The pattern of mean differences was almost exactly the same as the previous three measures. That is, people tended to base their decisions on throwing a pool party on Wednesday's forecast.

As with Study 1, it is important to note that analysis of the manipulation check indicated that cloudy was not a true "non-severe" forecast because participants rated this forecast as more risky than a sunny forecast. However, participants did rate the stormy forecast as more risky than the cloudy forecast. Generally, people tended to base their judgments about Friday's weather on Wednesday's weather. Although the pattern in Study 2 is similar to the pattern in Study 1, the interpretation of this particular pattern is different because of the type of anchors used in Study 2. In Study 2, participants viewed two irrelevant anchors before making a judgment about Friday's weather. When people saw Wednesday's weather they were influenced to assimilate their judgment towards this part of the anchor. These results suggest an anchoring-like effect because Wednesday's weather forecast is not sufficient information for judging Friday's weather. This effect is important because, from the participants' perspective, although the weather was the same on Monday and Wednesday, this should not matter for Friday's weather. If participants' predictions were not biased or using a heuristic, then predictions following these weather forecasts would not follow a consistent pattern, each participant would make a judgment at random.

These results also differ from Study 1 in that, occasionally, in Study 1 there was a unique influence of a stormy forecast such that people overestimated risk following some videos. The pattern of mean differences in Study 2, however, are not predicted by EMT (Haselton & Buss, 2000), because viewing stormy weather did not influence participants to overestimate the severity of Friday's weather.

General Discussion

These studies employed an anchoring-like paradigm that used uninformative, but qualitatively salient anchors presented to participants prior to making a qualitative estimate. I predicted that an anchoring-like bias would occur because the decision involves uncertainty. Anchoring-like is a better way to describe the expected bias because a traditional anchoring bias typically refers to a primacy effect. I conducted this study primarily to test which of two anchors (first or second forecast; severe or non-severe) would be more influential on later predictions or estimates. I predicted that if this anchoring-like bias had an adaptive function, then people would be more influenced by an anchor when one of the anchors had severity information (i.e., a stormy forecast or report) regardless of it being the first or second in the sequence. Both studies showed bias and that anchoring-like effects occurred because weather videos influenced predictions and estimates. Study 1 showed that in most cases the second forecast was more influential than the first forecast. Similarly, Study 2 showed that people were more likely to be influenced by Wednesday's forecast (the second forecast) when judging Friday's weather suggesting that, in this case, the order of weather forecasts was more important than quality of the forecast (i.e., stormy was not more influential). EMT was only partially supported only in Study 1 in that severe information influenced people to err on the side of caution especially when their predictions were made further from sunny after viewing stormy first and sunny second compared to viewing sunny first and second. Study 2 did not support the EMT hypothesis because, although involving a stormy weather report in the sequence lead to high estimates, these estimates were not uniquely higher than instances where there was a cloudy forecast.

Perhaps the EMT hypothesis was not consistently supported across both studies because the salience of the threat of the stormy forecast was not severe. In the manipulation check for both studies participants rated risk to safety higher following a single stormy forecasts compared to cloudy and sunny forecasts. However, the means for the stormy manipulation check for Studies 1 and 2 (*M* = 78.15 and 59.93 respectively) were not as extremely high as the mean estimates following sequences that had a stormy forecast in them (e.g., severity following stormy-then-stormy in Study 1 (*M* = 98.72) and Study 2 (*M* = 70.23). Further, although stormy was perceived as more severe than cloudy or sunny, the stormy forecast is not as life threatening as other types of weather. Previous research suggesting an anchoring effect on severity was done with hurricanes, severe winds, and ice storms (Losee et al., in prep; Joslyn et al., 2011). Therefore, perhaps stormy weather is not extreme or severe enough to have adaptive anchoring effects.

In addition to stormy not being severe enough, perhaps the manipulation did not truly isolate the quality of severity to only the stormy forecast. Although participants perceived cloudy as less severe than stormy, participants still assigned riskiness to cloudy in Study 1 and 2 (*M* = 35.65 and 33.07 respectively). Having this weakly severe forecast may have lead to the lack of difference between the conditions that contain stormy and those that contain cloudy. Indeed, if one considers cloudy to be sufficiently severe, then in Study 1, there is evidence for the EMT hypothesis on the prediction measure: When participants saw the cloudy forecast first and the sunny forecast second and when they saw the stormy forecast first and the sunny forecast second, they made predictions toward the severe end of the scale compared to when they saw the sunny forecast first and second.

The selective accessibility model of anchors possibly explains this finding. According to the selective accessibility model, semantic priming and hypothesis-confirmation testing are mechanisms through which anchoring occurs offering an explanation for the similarity between participants' judgments after viewing sequences containing cloudy and/or stormy warnings

(Mussweiler & Strack, 1999). To summarize, patterns that include cloudy and stormy forecasts may activate nodes closer together and closer to severity in the semantic network than those that contain only sunny forecasts. Cloudy forecasts are more likely to prime thoughts of stormy weather than sunny weather. It is possible that a sequence of predictions in which a stormy forecast follows a sunny forecast is perceived as unusual, perhaps prompting participants to attend to different aspects of the anchors. Some examples of this idea include differences where in Study 1, participants marked their prediction Friday's weather further away from cloudy after seeing the cloudy forecast first and seeing the stormy forecast second compared to after seeing the cloudy forecast first and the sunny forecast second. This difference may indicate a combined activation of cloudy and stormy to influence higher estimates. Additionally, on the same measure in Study 1, after seeing a cloudy forecast first and a sunny forecast second, participants marked their prediction further from sunny than after seeing a sunny forecast both first and second. This difference supports the idea that cloudy is closer to "severe" in the semantic network than sunny.

Additionally, the selective accessibility model and semantic priming may also explain why participants do not consistently estimate more severity after seeing stormy first and sunny second compared to seeing sunny first and second. In the latter case, stormy may weakly prime severity related nodes in the semantic network, which would explain the lack of consistently higher estimations following the stormy forecast.

To improve upon this design, future research should follow a network model perspective and test stimuli for their relative closeness to each other on the feature of severity such that truly different stimuli (severe vs. non-severe) can be used to assess the EMT hypothesis presented in this research. Should stimuli be sufficiently severe and non-severe following pilot testing, I would expect to see an adaptive anchoring-like bias after viewing severe stimuli.

The second part of the hypothesis dealt with an expectation of a less rational and functional anchoring bias when severity information was not included in the sequence. For Study 1, a traditional anchoring bias would have appeared as a bias towards the first forecast as the second forecast is indeed the most accurate and reasonable information. For Study 2, an anchoring-like bias was expected with estimates consistently influenced by either weather forecast and thus, influenced by irrelevant information. Unbiased judgments about Friday's weather in Study 2 would not have appeared so systematically influenced by the information in the second weather report if judgments were rational. In contrast, both studies yielded an anchoring-like effect on the second weather warning rather than the first.

Because anchoring has been studied in different ways, the literature refers to a variety of biases as anchoring (Chapman & Johnson, 2002; Jacowitz & Kahneman, 1995). Tversky and Kahneman (1974) suggest that anchoring occurs when a salient, uninformative number presented to a decision maker influences an estimate that assimilates with the presented anchor. Similarly, Jacowitz and Kahneman (1995) define anchoring as an arbitrary value that a person is caused to consider before making a numerical estimate. Based on these definitions, the present studies do not demonstrate a traditional anchoring bias because there is no influence of a numerical value. Instead, the present studies produce an anchoring-like effect where previous sequential, qualitative information influenced later estimates. The anchoring literature contains many explanations for anchoring-like biases that tend to explain anchoring effect based on type of anchor, such as experimenter generated, self-generated anchors (Epley & Gilovich, 2001) and sequential anchors (Hogarth & Einhorn, 1992). The *belief adjustment model* posits a general anchoring model where there should be primacy effects if judgments are made after an entire sequence of information and recency effects if judgments are made after each piece in a sequence of information (Hogarth & Einhorn, 1992). Participants in the present studies were making end-of-sequence judgments, which, according to both traditional anchoring and the belief adjustment model should have resulted in primacy effects. Instead, the second forecast or report was the most influential, thus showing a recency effect. This recency effect, however, is not uncommon in the literature, lending support to the idea that anchoring effects are primarily dependent on the type of anchors they follow rather than being dependent on a general mechanism of anchoring. For example, researchers used sequential anchors to study anchoring effects in assessments of athletes' ability (Smith, Greenlees, & Manley, 2009). These researchers found, that after viewing a sequence of footage about an athlete's performance, participants' judgments showed primacy effects whether they made the judgments after each piece of the video or after the entire video. Thus, inconsistent patterns across anchoring studies such as this show how the format of anchors can change the function of the heuristic. Indeed, Epley and Gilovich (2001) argue that anchoring can be produced via different mechanisms depending on the type of anchor.

Both studies showed an anchoring toward the second forecast, however, the interpretation of this pattern differs between studies because the type of anchors used in the two studies differed in their content. In Study 1, the anchors were relevant for making judgments about Friday's weather. In Study 1, making a judgment influenced by the second forecast was rational because the latest forecast in the real-world contains the most accurate and up-to-date information. In Study 2, both of the anchors were irrelevant for making judgments about Friday's weather. In addition to showing a strong influence of the second forecast, Study 1 showed occasional support for adaptive anchoring and traditional anchoring. Study 2 showed a primary influence of the second weather report, however, in this study, this pattern supports the idea of an anchoring-like bias because relying on the second forecast for judgment was irrational.

Differences in patterns between the two studies could also be related to anchor relevance and anchor salience. Although many studies have shown that irrelevant anchors still lead to anchoring effects (e.g., Tversky & Kahneman, 1974; Critcher & Gilovich, 2008), relevance has not been manipulated at as subtle a level as it has in these studies. For example, Tversky and Kahneman (1974) provided irrelevant anchors such as a roll on a numbers wheel prior to a making an unrelated judgment. Alternatively, anchors in Study 1 were more relevant than those in Study 2 and also were more likely to lead to overestimation, or adaptive bias. Study 2 included irrelevant anchors and lead to a more true anchoring effect (influence of prior information on later judgment) as predicted by Tversky and Kahneman (1974). Perhaps the anchoring effect leads to more overestimation of risk and erring on the side of caution when anchors are actually relevant. Testing this feature of relevance is important to provide a more comprehensive view of the effect of previous forecasts or weather forecasts on later judgments about a target day.

Like anchor relevance, anchor salience is a factor involved in influencing people's judgments. Anchor salience influences people to select the anchoring heuristic as a decision-making strategy when making a prediction under uncertainty. Influence of anchor salience on anchoring effects occurs because the participant perceives a central tendency of the salient anchor as it relates to the target and they adjust away from that (Czaczkes & Ganzach, 1996). If semantic priming is the mechanism through which the effects of the present studies are occurring (Mussweiler & Strack, 1999), then a less salient anchor may weakly prime activation of related nodes in the semantic network. If people did not perceive severity because the severe forecast was not saliently severe, then there would be less consistent adaptive bias in anchoring. Salience is a factor involved in anchoring (Czaczkes & Ganzach). Perhaps severity in the stormy forecast was not distant enough from cloudy or sunny and not near enough to a central tendency of severity that would have encouraged participants to rely on an adaptive anchoring bias.

Finally, these differences brought about by differences in anchor type support the notion of domain-specific cognitive mechanisms proposed by Cosmides (1989). It appears that the mechanism employed to solve a problem concerning uncertainty is selected by the information provided. The present research shows an adaptive anchoring-like overestimation-of-risk bias can emerge when anchors are relevant (i.e., weather forecasts for Friday when the judgment is about Friday) and a more irrational anchoring-like bias can emerge when anchors are irrelevant (i.e., unrelated weather forecasts for Monday and Wednesday when the judgment is about Friday). Indeed, domain-general explanations of anchoring-like mechanisms (e.g, the belief adjustment model; Hogarth & Einhorn, 1992) have failed to explain the present results and results of other studies (Smith et al., 2009). Thus, continued research is necessary to tease apart the different types of uncertainty information that select the different types of heuristics.

Limitations

Although portions of the hypothesis were supported on some measures, the results demonstrated somewhat inconsistent patterns between measures in each study. This inconsistency is likely due in large part to the small sample sizes for each question. The risk of a Type-II error is especially high in Study 2, where sample sizes on each measure were as low as 11. Compounding the problem of small sample sizes is the use of the conservative Bonferroni correction in post-hoc analyses. Using this method of post-hoc analysis increases risk of a Type-II error where differences that support the alternative hypothesis are not detected when they actually exist. However, I used the Bonferroni correction because I preferred the risk of a Type-

II error over the risk of a Type-I error which would have been high using Fisher's Least Significant Difference post-hoc. Both of these issues of power could be solved by collecting a sample size of at least 50 participants as recommended by Simmons, Nelson, and Simonsohn (2013).

Implications

Results of these two studies reveal important information about how people make predictions, estimates of severity and dangerousness, and how they make decisions about preparedness based on forecasts. Indeed, according to both studies, people's predictions, estimates, and decisions are biased by the forecasts and weather forecasts they hear before a given day. At face value, this is an obvious statement. However, these results show that the influence of previous forecasts is less rational and more biased. In Study 1, a rational influence of previous weather forecasts would have been judgments based only on the second, most accurate forecast. However, there were biased judgments based on severe information and occasionally on the first forecasts. The existence of a weather judgment bias is important. The goal of meteorologists is to create increasingly accurate forecasts. However, accurate forecasts and weather forecasts still may influence people to make irrational or biased decisions. Furthermore, in Study 2, there was a consistent pattern where the second weather forecast was the most influential on people's judgments of what the weather would be on a later unrelated day. Rationally, there should not have been an influence of either first or second weather forecast because they were both irrelevant to the actual target day. Thus, if people are being rational, there should have been no pattern in predictions and estimates. However, the fact that there was an influence of this irrelevant information suggests that people are using a heuristic under this type of uncertainty. Again, this knowledge is important for meteorologists as there may be ways to present information so that people are able to use heuristics in a beneficial rather than harmful way. For example, Joslyn and LeClerc (2013) argue that providing uncertainty estimates in forecasts facilitate accurate and rational processing of information.

Future Directions

The use of the anchoring heuristic in making judgments about a target day's weather should be studied in greater detail because of the importance of risk perception in preparedness (PMT; Rogers, 1975; PADM; Lindell & Perry, 2012; Mulilis, 1995). Thus, this study should be replicated with a larger sample size to increase power and reduce the likelihood of a Type-II error.

Additionally, to assess the importance of relevance of the anchor, a simpler design could test making judgments about Friday's weather based on either a single prediction for Friday (relevant anchor) or a weather report for Wednesday (irrelevant anchor) where the information varies in severity to see if this variable is influential in this case. Based on the results of the present study, I expect that the relevant anchor would lead to little adjustment away from the anchor and that the irrelevant anchor should lead to either similar adjustment if relevance is not a factor. If relevance is a factor, then the irrelevant anchor will lead to adjustment further away than adjustment following the relevant anchors.

Furthermore, salience of threat should be manipulated to further assess the influence of anchor salience on the results reported here. To the test this prediction, participants could make judgments about Friday's weather based on a series of forecasts that varied in severity and that varied in salience. For instance participants could view relevant forecasts with low salience (forecast without sound and pictures), medium salience (stimuli used for this study), and high salience (sound and pictures depicting increased direness of the threat) before making the judgments about Friday's weather. These levels of salience would be formatted according to information gained from assessing the stimuli's closeness in the semantic network as proposed earlier. I predict that the most saliently severe forecast would lead to the adaptive anchoring effects expected in the present research. In conclusion, because anchor type (relevance and salience) is important to the form of anchoring effect, each feature of the anchor is important to understand. This understanding is important because it is the initial perception of severity in a timely warning that will encourage people to act in the face of threatening weather.

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Appendix A: Informed Consent

GEORGIA SOUTHERN UNIVERSITY

COLLEGE OF LIBERAL ARTS AND SOCIAL SCIENCES

DEPARTMENT OF PSYCHOLOGY

INFORMED CONSENT

Weather Prediction

1. Joy Losee, Graduate student in the Department of Psychology, Karen Naufel, Associate Professor of Psychology, are conducting this research to gain information about weather warnings.

2. Purpose of the Study: The purpose of this study is to examine how people perceive weather warnings.

3. Procedures to be followed: Participation in this research will include viewing weather warnings and completing questionnaires about your judgments of these warnings.

4. Discomforts and Risks: This experiment does not pose any risks to you beyond those encountered in everyday life. Possible risks include feeling uncomfortable in imagining a potential weather hazard. If you experience discomfort, you have the right to withdraw at any time without loss of benefits. This means that you can withdraw from the study and still receive credit.

5. Benefits:

a. The benefits to participants include increasing their awareness of weather risk.

b. The benefits to society include gaining an understanding of how people perceive weather risk.

6. Duration/Time: This experiment will last 30 minutes or less.

7. Statement of Confidentiality: Your responses in this experiment will be confidential. Only a code number will be used to identify your responses, this code will not be linked to your name.

Your data will be stored in a secure place, protected to the fullest extent of the law. The data will be maintained for at least seven years, according to American Psychological Association guidelines.

8. Right to Ask Questions: You have the right to ask questions and have those questions answered. If you have questions about this study, please contact the researchers named above. For questions concerning your rights as a research participant, contact Georgia Southern University Office of Research Services and Sponsored Programs at 912-478-0843, or research@georgiasouthern.edu.

9. Compensation: You will receive 1 research credit for participating in this study, which will factor into your grade according to the guidelines established by your instructor of Introduction to Psychology. You have other options for completing your research requirement. If you decide not to participate, see your instructor for alternative credit opportunities.

10. Voluntary Participation and Right to Withdraw: Because your participation in this study is voluntary, you may decline to answer specific questions or you may withdraw from participation at any time. Your decision of whether or not to participate will not jeopardize your future relations with Georgia Southern University, the Psychology Department, or the faculty member in charge of this project. You will still receive credit for this study if you choose to withdraw.

11. Penalty: If you decide not to participate, there will be no penalty, no retribution, and no loss of benefits. If you have any questions or experience any adverse effects as a result of participation, please contact Dr. Naufel at knaufel@georgiasouthern.edu. You may also call Georgia Southern's Counseling and Psychological Center at 912-478-5541.

12. You must be 18 years of age or older to consent to participate in this research study. If you consent to participate in this research study and to the terms above, please sign your name and indicate the date below

You will be given a copy of this consent form to keep for your records. This project has been reviewed and approved by the GSU Institutional Review Board under tracking number H__________.

Title of Project: Weather Prediction

Principal Investigator: Joy Losee
PO Box 8041
Georgia Southern University
Statesboro, GA 30460
e-mail: Jl01745@georgiasouthern.edu
Faculty Advisor: Karen Naufel
e-mail: knaufel@georgiasouthern.edu
PO Box 8041
Georgia Southern University

Statesboro, GA 30460

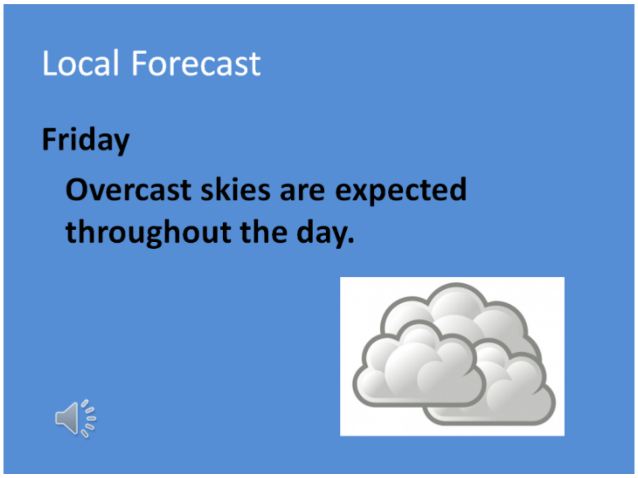
______________________________________ _____________________
Participant Signature Date

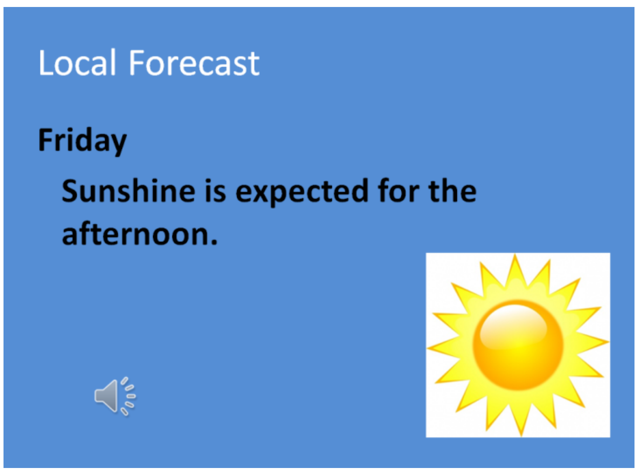
I, the undersigned, verify that the above informed consent procedure has been followed.

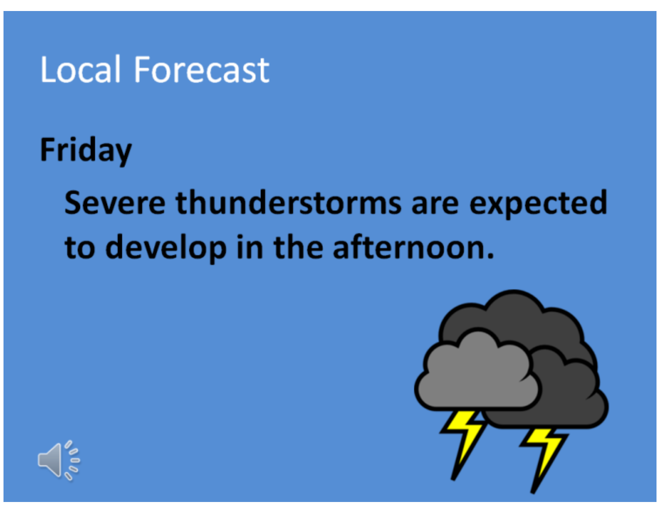
______________________________________ _____________________
Investigator Signature Date

______________________________________ _____________________
Investigator Signature Date

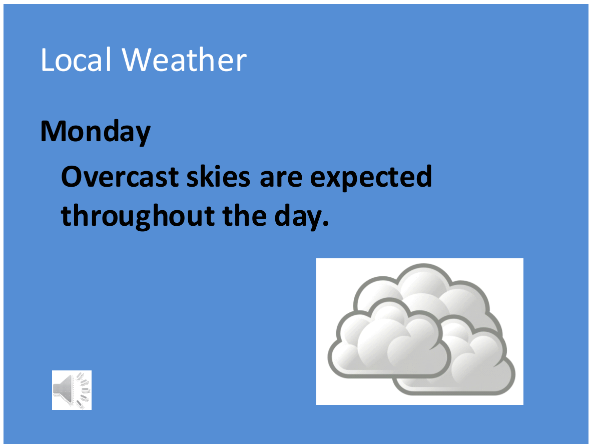
Appendix B1: Stimuli

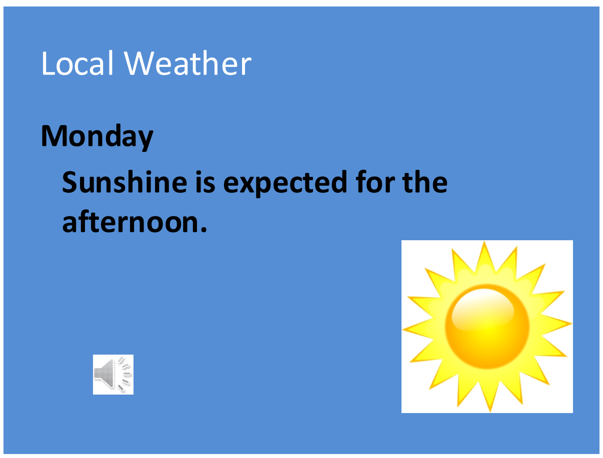


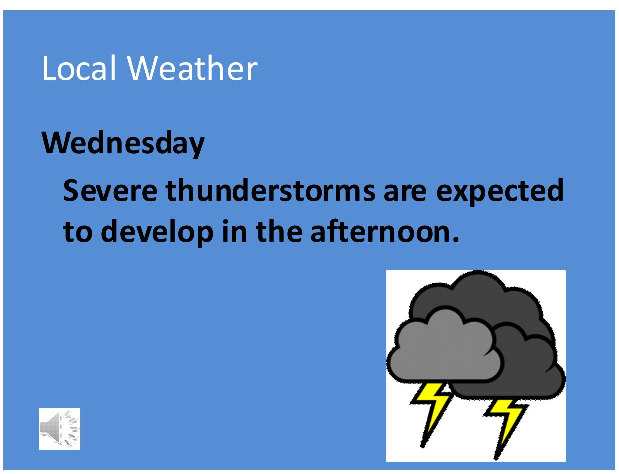




Appendix B2: Stimuli







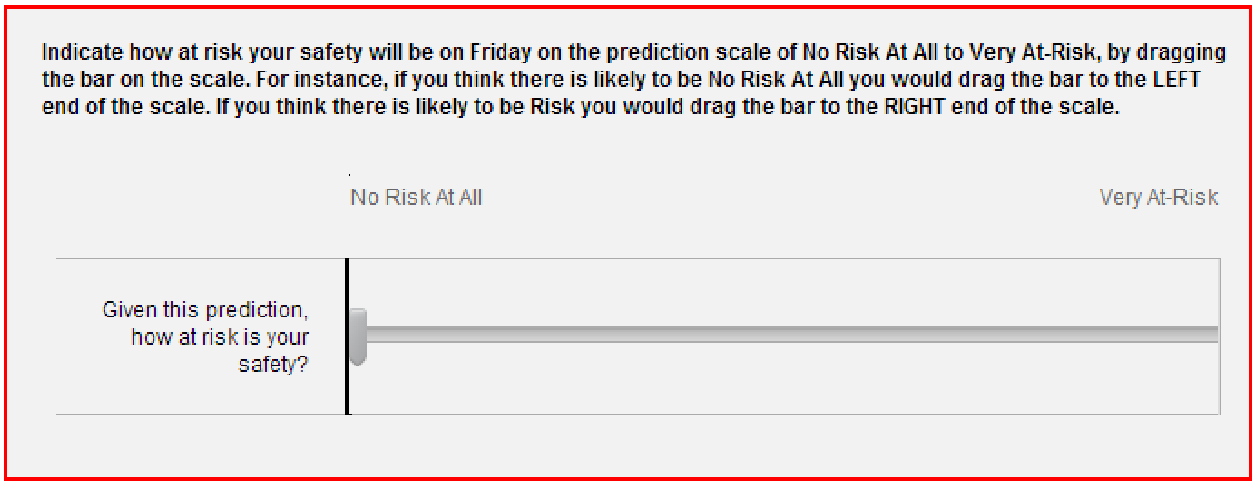
Appendix C: Measures

Manipulation Check

Which of these weather events pose a safety risk for a pool party?

- Sunny
- Cloudy
- Stormy

Practice Trials


Indicate how at risk your safety will be on Friday on the prediction scale of No Risk At All to Very At-Risk, by dragging the bar on the scale. For instance, if you think there is likely to be No Risk At All you would drag the bar to the LEFT end of the scale. If you think there is likely to be Risk you would drag the bar to the RIGHT end of the scale.

No Risk At All

Very At-Risk

Given this prediction, how at risk is your safety?

Experimental Trials

Weather Prediction

Predict Friday's weather on this scale:

Sunny____ Stormy

Severity

How severe will Friday's weather be?

Not Severe____________________________________ Severe

Dangerousness

How dangerous will Friday's weather be?

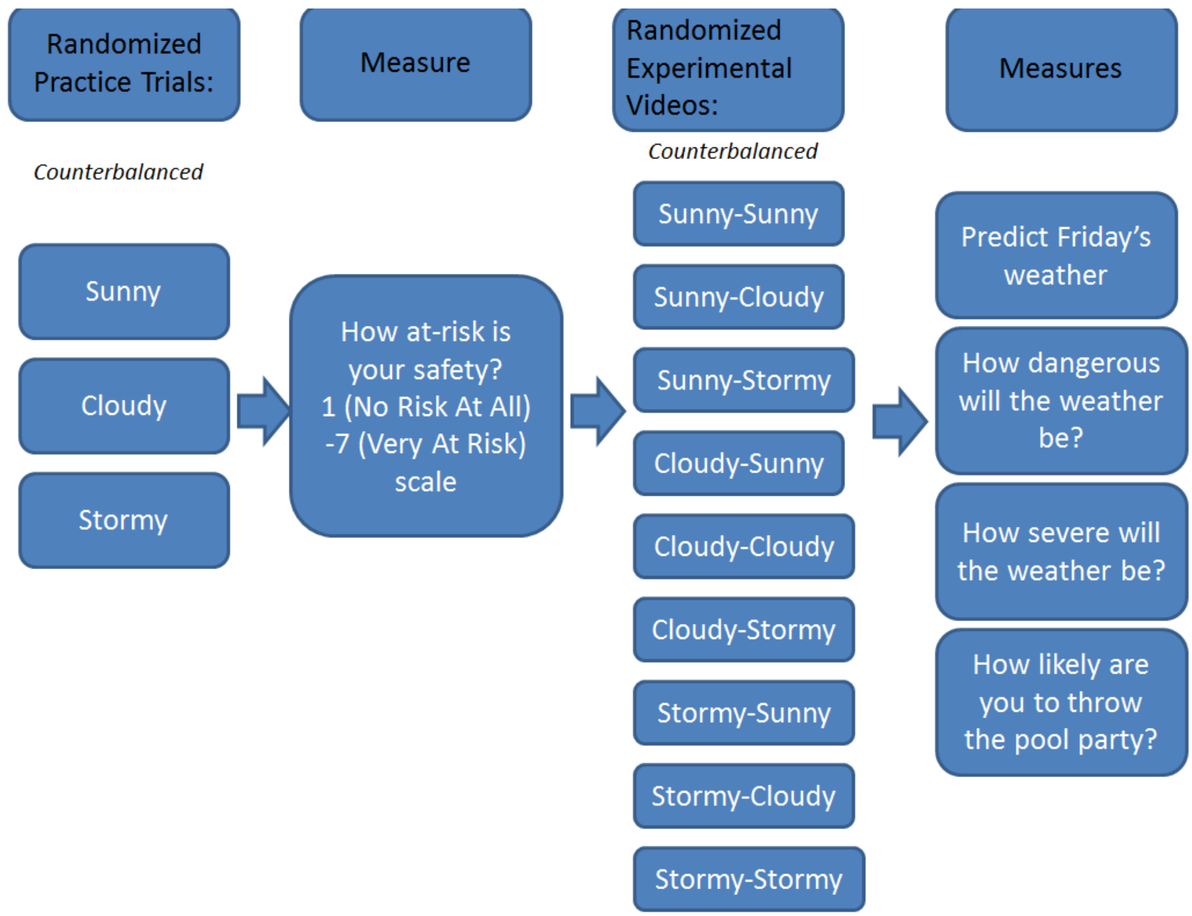
Not Dangerous____________________________________ Dangerous

Decision to hold pool party

How likely are you to throw the pool party on Friday?

Not Likely____________________________________ Likely

Appendix D: Timeline of Procedure



Appendix E

Pre-Session Set-up:

- *Wipe headphones with Clorox wipes.*
- *Go to SONA: http://class.georgiasouthern.edu/psychology/sona.php*
- *Look at your time slots and note the names of who has signed up for your sessions.*
- *Pull up the Qualtrics survey on each computer.*

Good [Morning/Afternoon],

You can follow me. Have a seat at either of the computers with headphones. [They sit down]

Welcome to the Pool Party study. My name is _______ and I will be your experimenter. Today, you will be making decisions as a party planner about whether or not to hold a pool party based on two weather forecasts[reports] that you see first early in the week and then second later in the week. Let's first go over the informed consent. [Hand them each an informed consent sheet].

There are two things you should be aware of. First, you have the right to confidentiality. Any information you provide will not be linked to your name, and your identity will be protected to the fullest extent of the law. Second, you have the right to voluntary participation and right to withdraw. If at any time you feel this experiment is too stressful for you, or you simply do not wish to continue, let me know and I'll stop the experiment with no loss of benefits. This means you can stop at any time and still receive credit.

Please carefully read over the informed consent. There are two copies of the form and after you've finished reading it, please sign one and hand it back to me. The other form is for you to keep.

[After the participants have clicked "Yes, I would like to participate" on the informed consent], There are headphones sitting in front of you. When I tell you to begin, please put them on. After you put on the headphones, please carefully read the instructions on the screen. After reading the instructions, please click "continue" to begin the experiment. Please carefully follow all instructions as you go through the study and let me know if you have any questions. You may begin.

[After participants go through the survey make sure that they are done. Thank them, and tell them they will be awarded credit as soon as possible].

Post-session Checklist:

- Make sure Qualtrics recorded their responses.
- Log-in to SONA again and award credit
    - *View/Administer Timeslots*
    - *Click "modify" next to the timeslot that was just completed*
    - *On the "timeslot information" page, scroll down to "sign-ups". Award 1 point of credit.*
    - *Do not penalize no-shows, simply do not award credit.*
- Do a session report for each session
    - *On a sheet of paper, write:*
        - *Your name*
        - *The date and time of session*
        - *The participant number*
        - *Write about any unusual that happened during the course of the experiment. If the session ran smoothly, write that as well.*

Table 1.
Means and standard errors of the mean from "What will the weather be on Friday?"

	First Forecast		
Second Forecast	Sunny	Cloudy	Stormy
Sunny	1.06 (.39)	11.83_{c}(2.17)	15.94_{c}(2.98)
Cloudy	42.44_{a}(2.26)	$50.06_{a,d}$(.44)	$58.22_{a,d}$(3.94)
Stormy	85.17_{b}(4.96)	$92.89_{b,e}$(2.11)	$98.72_{b,e}$(.74)

Note. Standard errors are in parentheses. Significant differences do not share subscripts, $p < 0.05$.

Table 2.

Means and standard errors of the mean from "How severe will the weather be on Friday?"

	First Forecast		
Second Forecast	Sunny	Cloudy	Stormy
Sunny	1.21_{a} (.53)	$7.07_{a,b,d}$(2.17)	$8.71_{a,b,d,e}$(2.95)
Cloudy	$21.29_{a,b}$(5.49)	$29.07_{b,e}$(5.40)	41.29_{e}(6.47)
Stormy	89.29_{c}(2.25)	$92.14_{c,f}$(2.01)	98.71_{f}(.55)

Note. Standard deviations are in parentheses. Significant differences do not share subscripts, p > 0.05.

Table 3.

Means and standard errors of the mean from "How dangerous will the weather be on Friday?"

	First Forecast		
Second Forecast	Sunny	Cloudy	Stormy
Sunny	$.94_{a}$(.46)	$5.82_{a,b,d}$(1.69)	$12.65_{b,d,e}$(3.08)
Cloudy	19.53_{b}(4.33)	$19.18_{b,e}$(3.28)	$33.77_{b,e}$(5.70)
Stormy	88.53_{c}(2.98)	$93.47_{c,f}$(1.44)	$98.18_{c,f}$(.73)

Note. Standard deviations are in parentheses. Significant differences do not share subscripts, $p >$ 0.05.

Table 4.

Means and standard errors of the mean for "How likely are you to throw the pool party on Friday?"

	First Forecast		
Second Forecast	Sunny	Cloudy	Stormy
Sunny	99.15_{a}(.55)	$91.15_{a,b,d}$(3.49)	$91.08_{a,b,d}$(2.56)
Cloudy	$77.23_{a,b}$(6.12)	$68.23_{b,e}$(6.19)	$56.08_{b,c,e}$(7.77)
Stormy	18.23_{c}(5.98)	$7.54_{c,f}$(3.83)	$2.69_{c,f}$(1.28)

Note. Standard deviations are in parentheses. Significant differences do not share subscripts, $p > 0.05$.

Table 5.
Means and standard errors of the mean from "What will the weather be on Friday?"

	Monday's Forecast		
Wednesday's Forecast	Sunny	Cloudy	Stormy
Sunny	7.77_{a}(2.56)	$19.39_{a,b,d}$(4.34)	$20.26_{a,b,d,g}$(4.19)
Cloudy	40.00_{b}(6.18)	$59.39_{b,c,e}$(6.34)	$46.92_{b,c,d,e,f,g}$(8.26)
Stormy	$60.54_{b,c}$(4.71)	$65.62_{b,c,e,f}$(7.84)	$70.23_{b,c,e,f}$(9.84)

Note. Standard deviations are in parentheses. Significant differences do not share subscripts, $p >$ 0.05.

Table 6.

Means and standard errors of the mean from "How severe will the weather be on Friday?"

		Monday's Forecast	
Wednesday's Forecast	Sunny	Cloudy	Stormy
Sunny	5.20_{a}(1.89)	$12.33_{a,d}$(3.63)	$16.47_{a,b,d,g}$(4.50)
Cloudy	39.07_{b}(5.82)	$47.87_{b,c,e}$(5.46)	$34.07_{a,b,c,d,e,f,g}$(6.82)
Stormy	$44.87_{b,c}$(7.08)	$62.20_{b,c,e,f}$(8.11)	$70.67_{b,c,e,f}$(8.30)

Note. Standard deviations are in parentheses. Significant differences do not share subscripts, $p >$ 0.05.

Table 7.

Means and standard errors of the mean from "How dangerous will the weather be on Friday?"

	First Forecast		
Wednesday's Forecast	Sunny	Cloudy	Stormy
Sunny	7.06_{a}(2.70)	$11.00_{a,b,d}$(3.41)	$15.81_{a,b,d,g}$(4.36)
Cloudy	35.13_{b}(6.29)	$42.63_{b,c,e}$(6.76)	$29.00_{a,b,c,d,e,g}$(5.63)
Stormy	$42.94_{b,c}$(6.14)	$63.56_{b,c,e,f}$(7.45)	$60.94_{b,c,e,f}$(9.42)

Note. Standard deviations are in parentheses. Significant differences do not share subscripts, $p > 0.05$.

Table 8.
Means and standard errors of the mean from "How likely are you to throw the pool party on Friday?"

	Monday's Forecast		
Wednesday's Forecast	Sunny	Cloudy	Stormy
Sunny	95.06_{a}(2.68)	$83.78_{a,b,c,d}$(5.94)	$86.28_{a,b,d,g}$(3.84)
Cloudy	62.72_{b}(7.03)	$49.83_{b,c,e}$(8.01)	$63.67_{a,b,c,d,e,g}$(7.87)
Stormy	$44.44_{b,c}$(7.12)	$27.50_{b,c,e,f}$(7.83)	$29.00_{b,c,e,f}$(8.82)

Note. Standard deviations are in parentheses. Significant differences do not share subscripts, $p > 0.05$.