Probabilistic Tornado Warning

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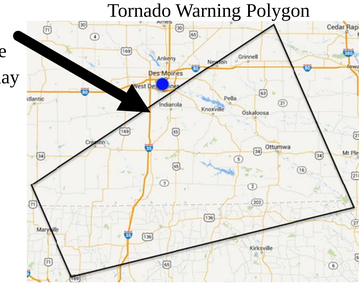
Background and Research Goals

- Current tornado warning polygon is deterministic, implying tornado will occur inside and not outside
- Tornado likelihood varies within the polygon & may benefit residents if carefully communicated (Joslyn & LeClerc, 2013)
- Some believe color-coding is suited to conveying within the polygon (Ash et. al., 2014)
- However color-coding could be misunderstood as indicating severity
- Research Questions:
  1) Do probabilistic warning formats increase understanding, trust and decision quality compared to the deterministic format?
  2) How do color-coded formats perform compared with numeric expression (tabular) formats?

Tornado Warning Polygon



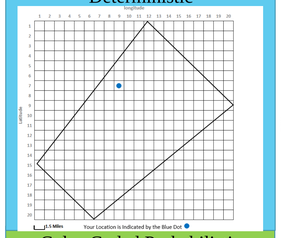
Mixed-Model Experimental Design

- Scenario: Imagine that you were traveling in the Southeastern US and received tornado warning from a cell phone app. The potential windspeed of the tornado was 86-135 miles per hour. Do you want to take shelter?
- 68 trials in total
- Severity held constant by holding windspeed constant (86-135 miles per hour)

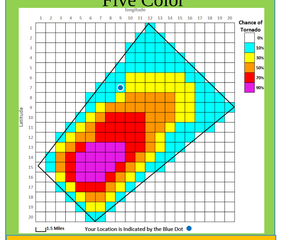
Two independent variables (IVs):

1) Forecast Format: 3 Levels Between-Subject
   Participant location = Blue Dot (or Square)

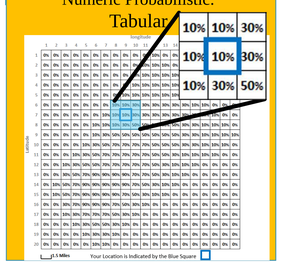
Deterministic



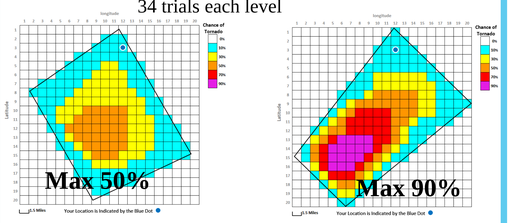
Color-Coded Probabilistic: Five Color



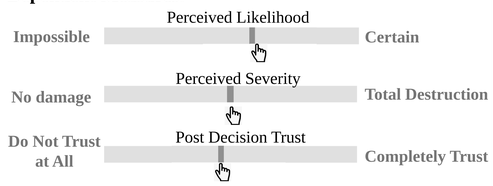
Numeric Probabilistic: Tabular



2) Max Probability: 2 Levels Within-Subject
   The highest forecasted likelihood in the polygon was 50% or 90%
   34 trials each level



Dependent Measures:



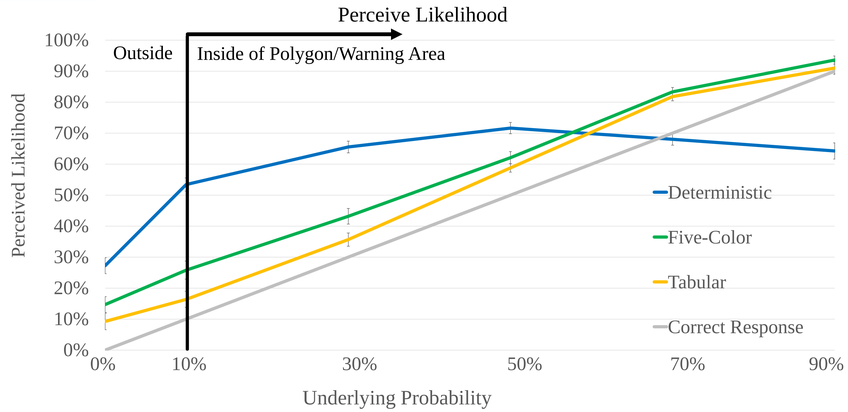
Point Structure:

- Participants started with 25,000 points

Decisions	Cost	Penalty in case of a tornado hit
Take shelter	90 points	0 points
Not to take shelter	0 points	1000 points

- Optimal decision based on expected loss:
  Expected loss of not sheltering:
  1000 points x probability of tornado
  Expected loss of sheltering: 90 points
- Shelter when likelihood >= 9%
- Participants: 221 (53% female) Amazon Mechanical Turkers

Results

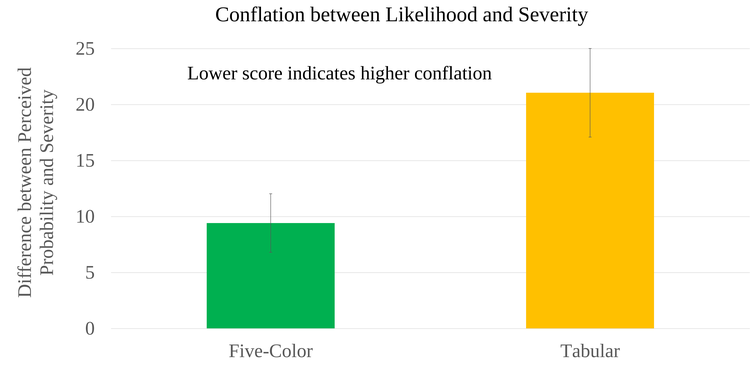


Probabilistic conditions: More accurate understanding of likelihood
Deterministic condition: Uniform ratings inside the polygon (F (4, 216) = 6.55, p <0.0001)

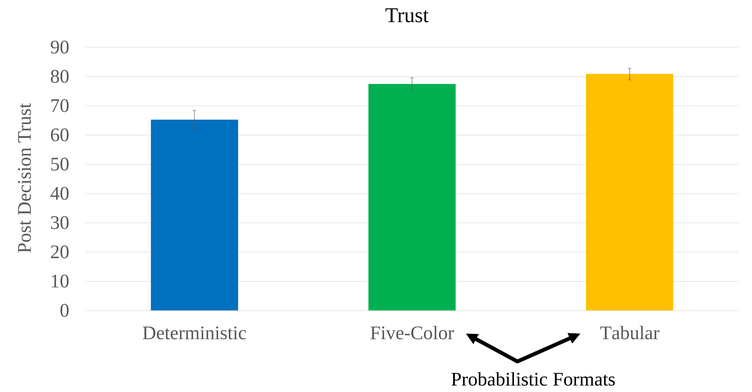
Deterministic condition: More sheltering at lower Underlying Probability but less at higher end
(F (4,216) = 6, p = 0.0001)

Color-coded probabilistic conditions: Biased by highest displayed probability
(F (4,216)= 26.35, p < 0.0001)

Results Cont.



Tabular: Significantly greater difference between likelihood & severity, less conflation
(F (4,216) = 4.851, p = 0.0009)



Probabilistic: Higher trust (F (4,216) = 5.797, p = 0.0002)

Conclusions

- Probabilistic warnings can improve participants' understanding & trust of tornado warnings
- Color-coding can lead to misunderstanding
  - Conflation between likelihood and severity was higher
  - Biased by nearby locations
- Decision quality equivalent overall
  - Deterministic format sheltered more often at lower probability, where the optimal strategy was to shelter, but less at higher probability

References

Joslyn, S., and Leclerc, J. (2013). Decisions With Uncertainty: The Glass Half Full. *Current Directions In Psychological Science*, *22*(4), 308-315.

Ash, K. D., Schumann, R. L., & Bowser, G. C. (2014). Tornado Warning Trade-Offs: Evaluating Choices for Visually Communicating Risk. *Weather, Climate, and Society, 6*(1), 104–118.

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