Tornado Warning Reception, Comprehension, and Response across County Warning Areas in the Contiguous United States

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Motivation

- NWS forecasters and partners have many responsibilities
  - Advisories and warnings
  - Advice, education, and guidance to people in the community during high impact weather events
- Risk communication across this range of responsibilities requires systematic, robust, and intimate knowledge of the community
  - Difficult to obtain and hard to pass on to forecasters who are often transplants in the communities they serve
- ***Forecasters and partners have little or no social data on the communities they serve***
  - How many people in *my* CWA receive, understand, and respond to extreme weather forecasts and warnings?
  - How does *my* CWA compare to other CWAs?

Severe Weather and Society Survey

- **Goals**
  - Develop baseline measures of forecast and warning reception, comprehension, and response
  - Use these measures to track reception, comprehension, and response across communities over time
- **Methodology**
  - Yearly public surveys that include baseline questions on reception, comprehension, and response and experiments on new topics and issues
- **Progress**
  - Pilot surveys in Spring 2012 & 2013; complete surveys in Spring 2017 & 2018
  - Baseline measures of *tornado* warning reception, comprehension, and response (PoC)
  - Working to develop and validate a methodology to track these measures across geographic areas (CWAs)

Severe Weather and Society Survey (2018)

- Baseline questions on tornado warning reception, comprehension, and response; experiments on how people interpret probabilistic language
  - **Fielded**: July 6-11, 2018
  - **Sample**: 3,000 adults (age 18+) across the CONUS
  - **Mode**: online questionnaire
  - **Completion time**: ~20 minutes
  - **Weights**: match Census estimates for age, gender, ethnicity, race, and region

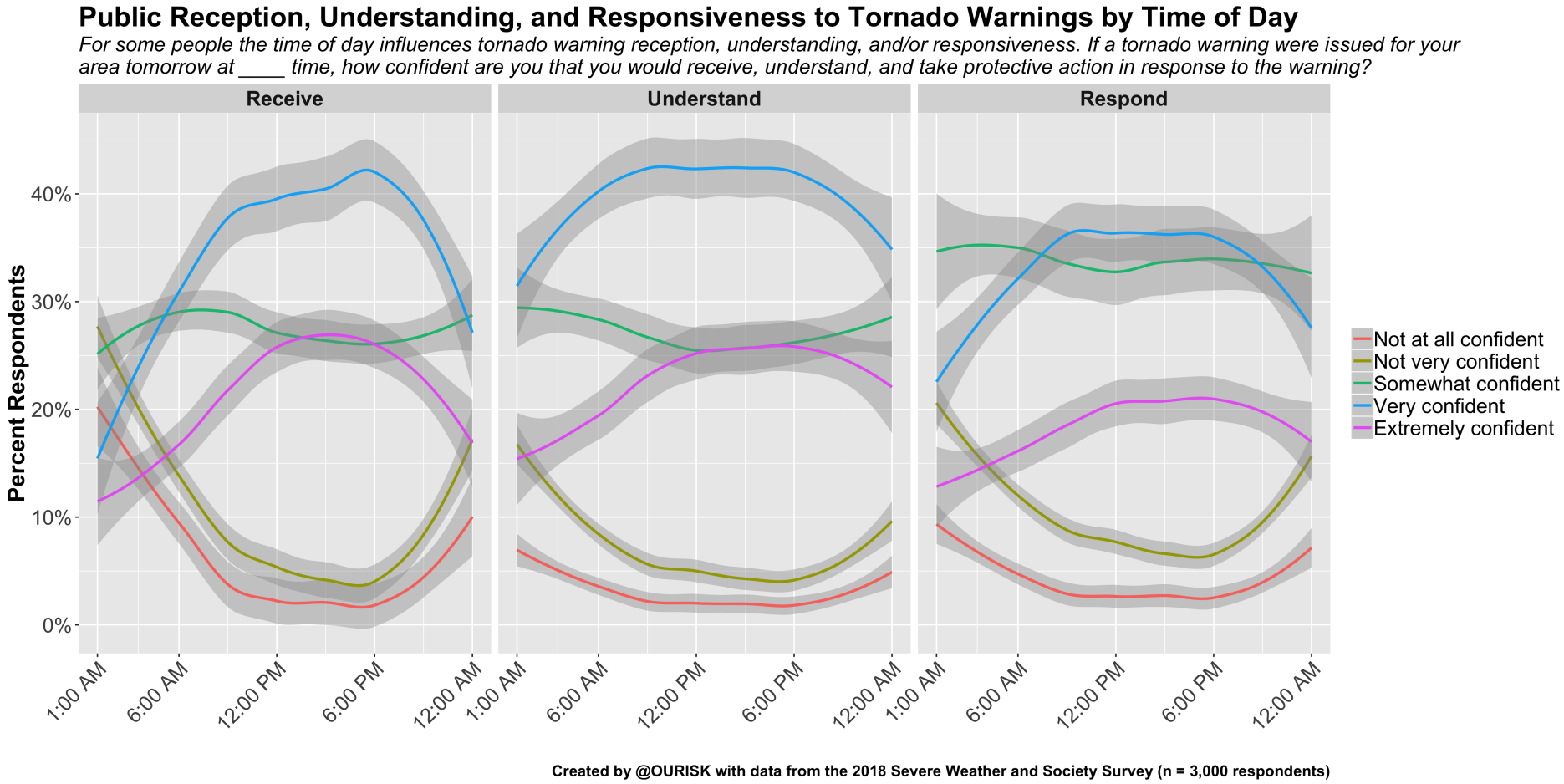
Baseline Measures

- Develop and validate four composite scales that measure:
  1. Tornado warning reception (subjective) $\rightarrow$ 12 questions
  2. Tornado warning comprehension (objective) $\rightarrow$ 4 questions
  3. Tornado warning comprehension (subjective) $\rightarrow$ 8 questions
  4. Tornado warning response (subjective) $\rightarrow$ 10 questions
- Use a combination of factor analysis and item response theory to show that scales are valid and reliable
- Adequately discriminate between low, average, and high ability

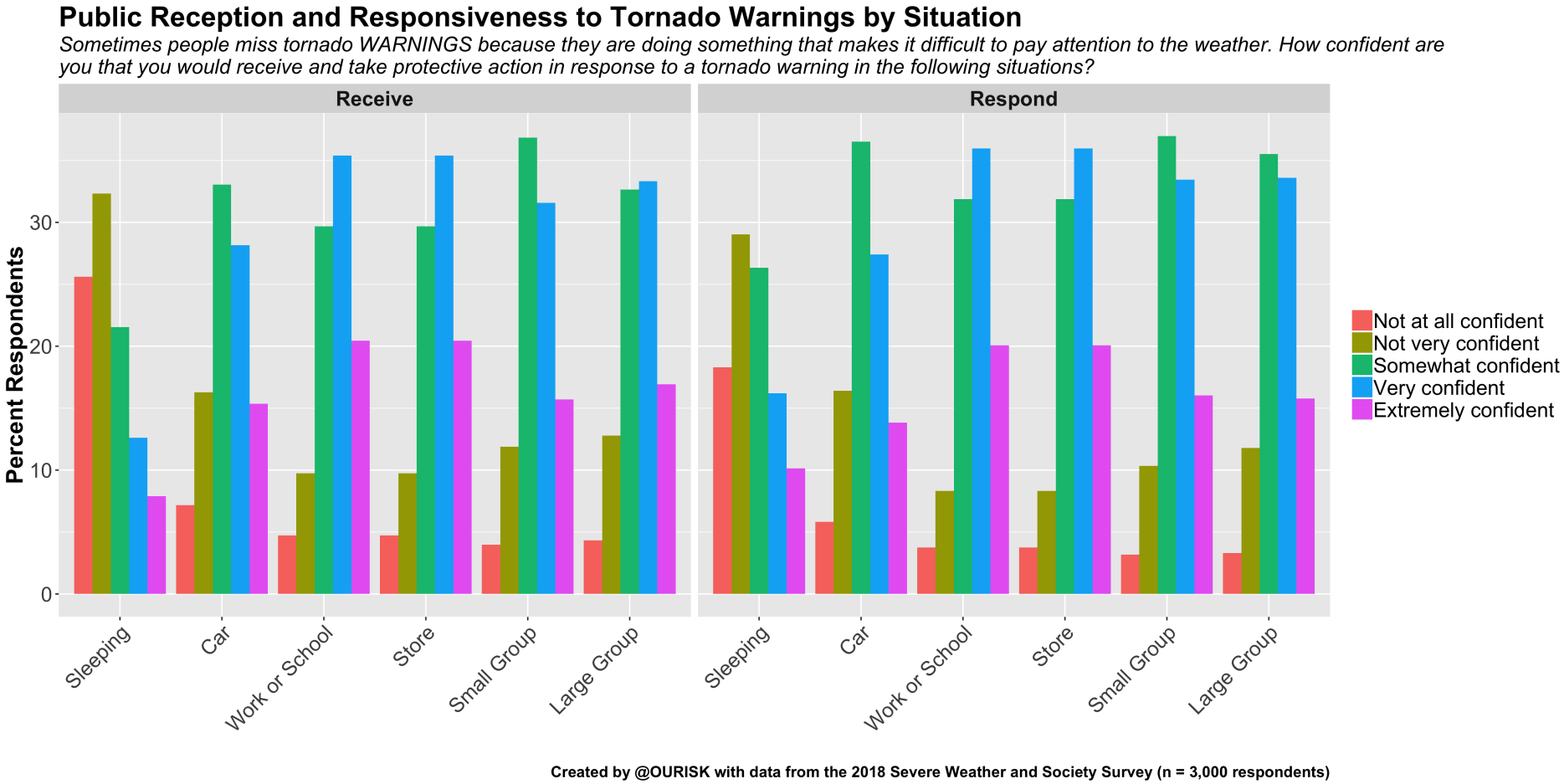
Example Questions

- **Time of day:** If a tornado WARNING were issued for your area tomorrow at [RANDOM TIME], how confident are you that you would [receive] [understand] [take protective action in response to] the warning?
- **Situation:** How confident are you that you would [receive] [take protective action in response to] a tornado warning in the following situations?
- **Leadtime:** If the National Weather Service issues a tornado warning for your area, how much time do you have before the tornado arrives?

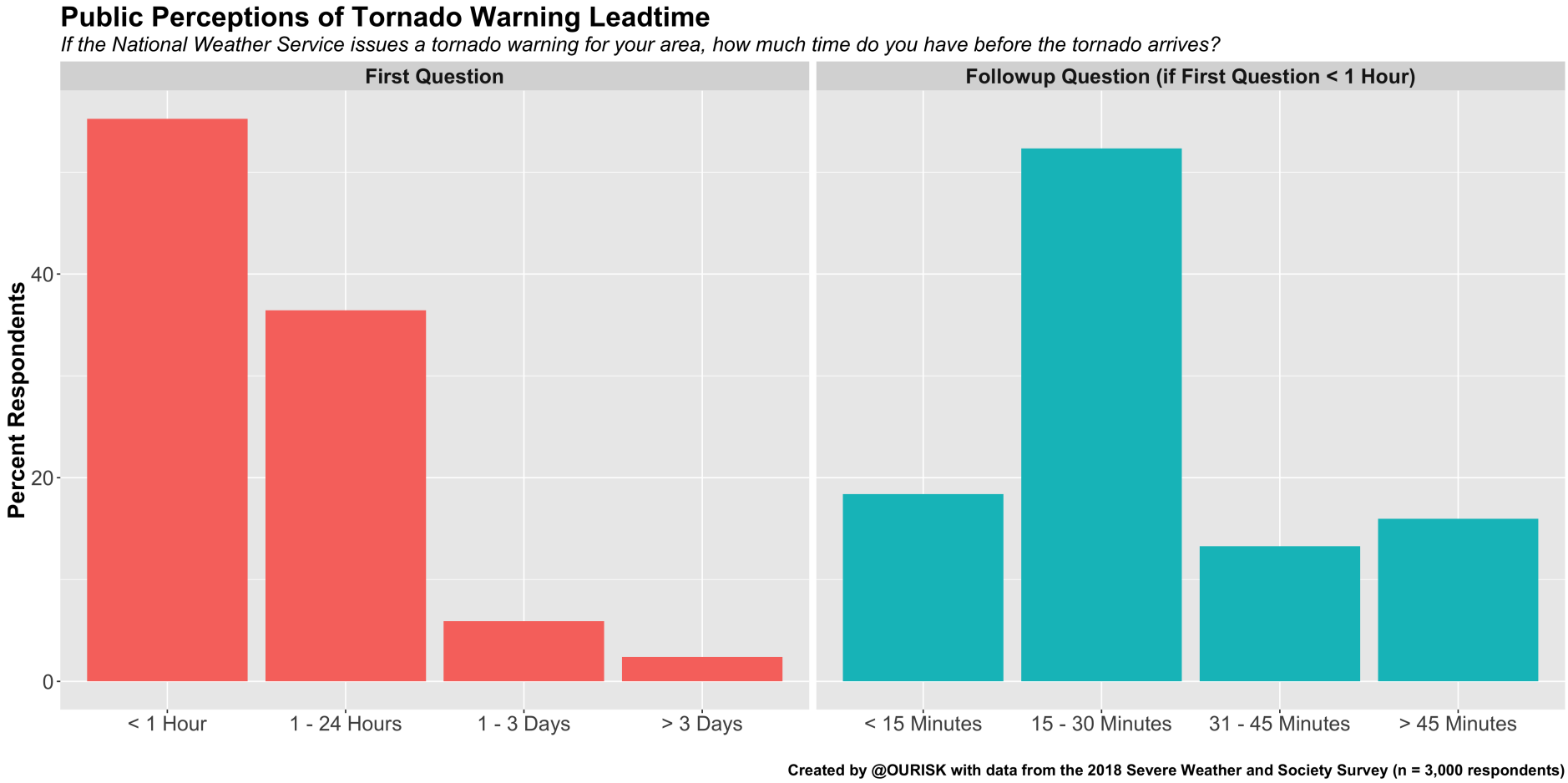
Example Findings (Time of Day)



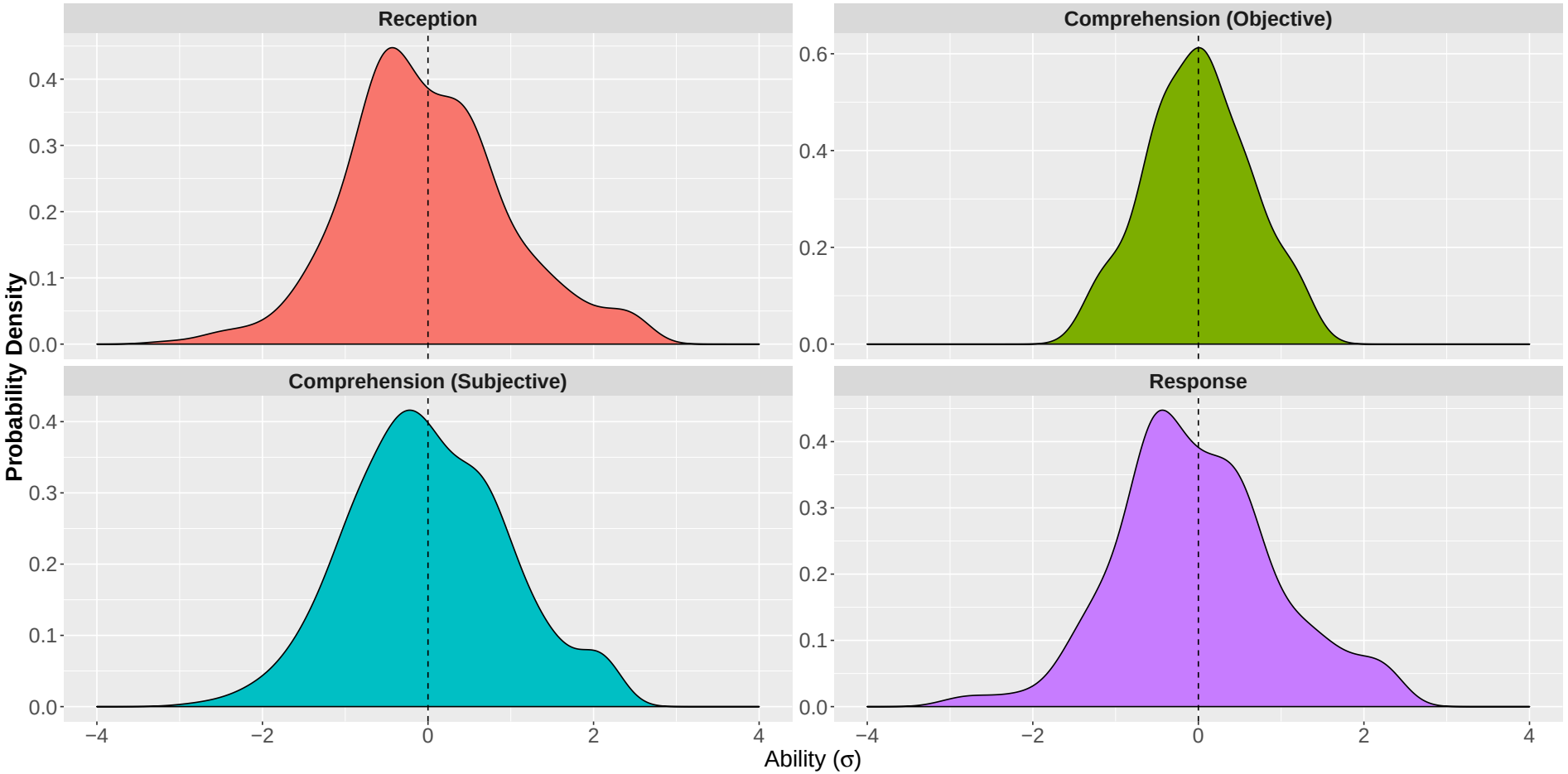
Example Findings (Situation)



Example Findings (Leadtime)



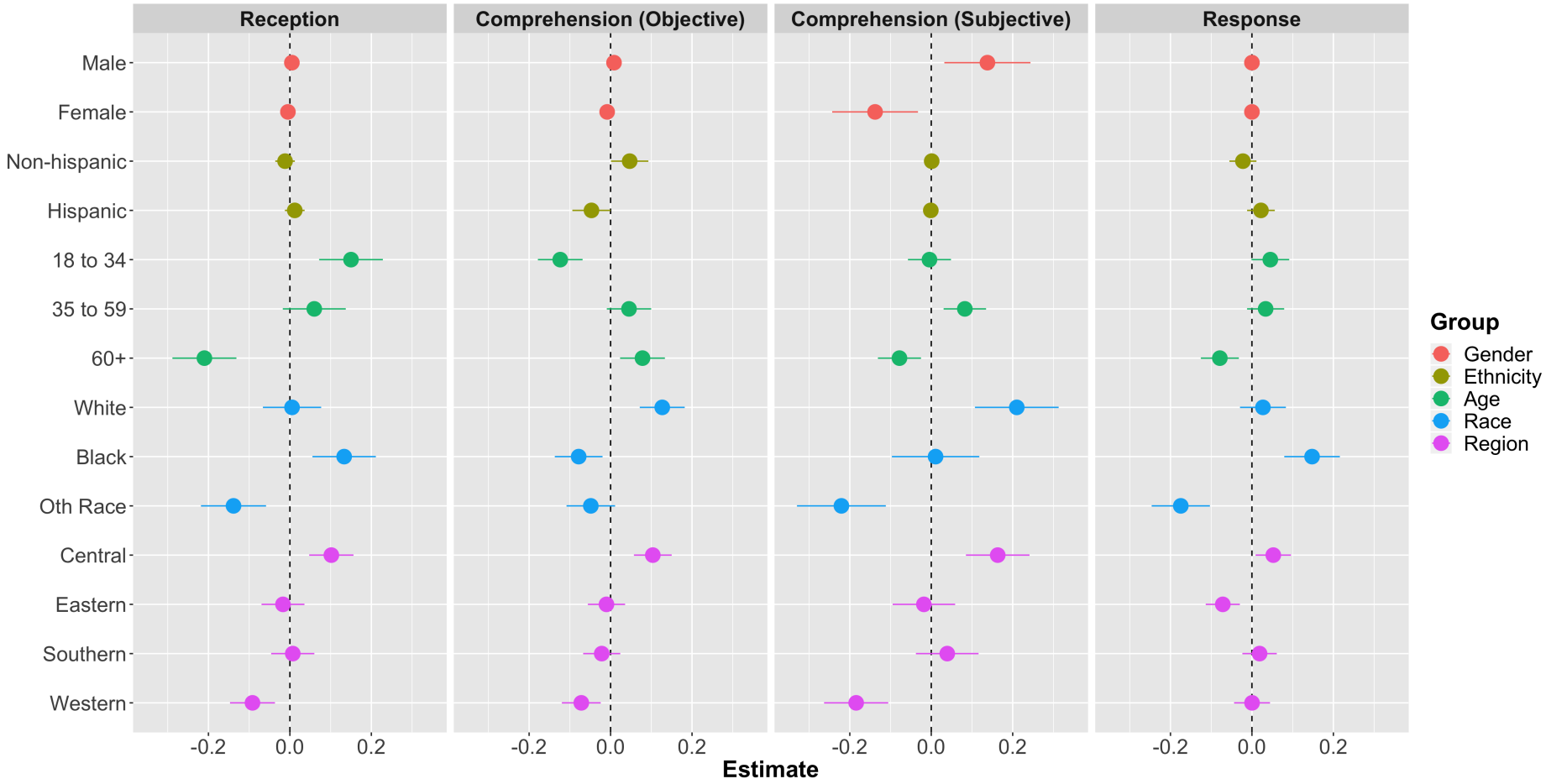
Composite Scale Distributions (Across the CONUS)



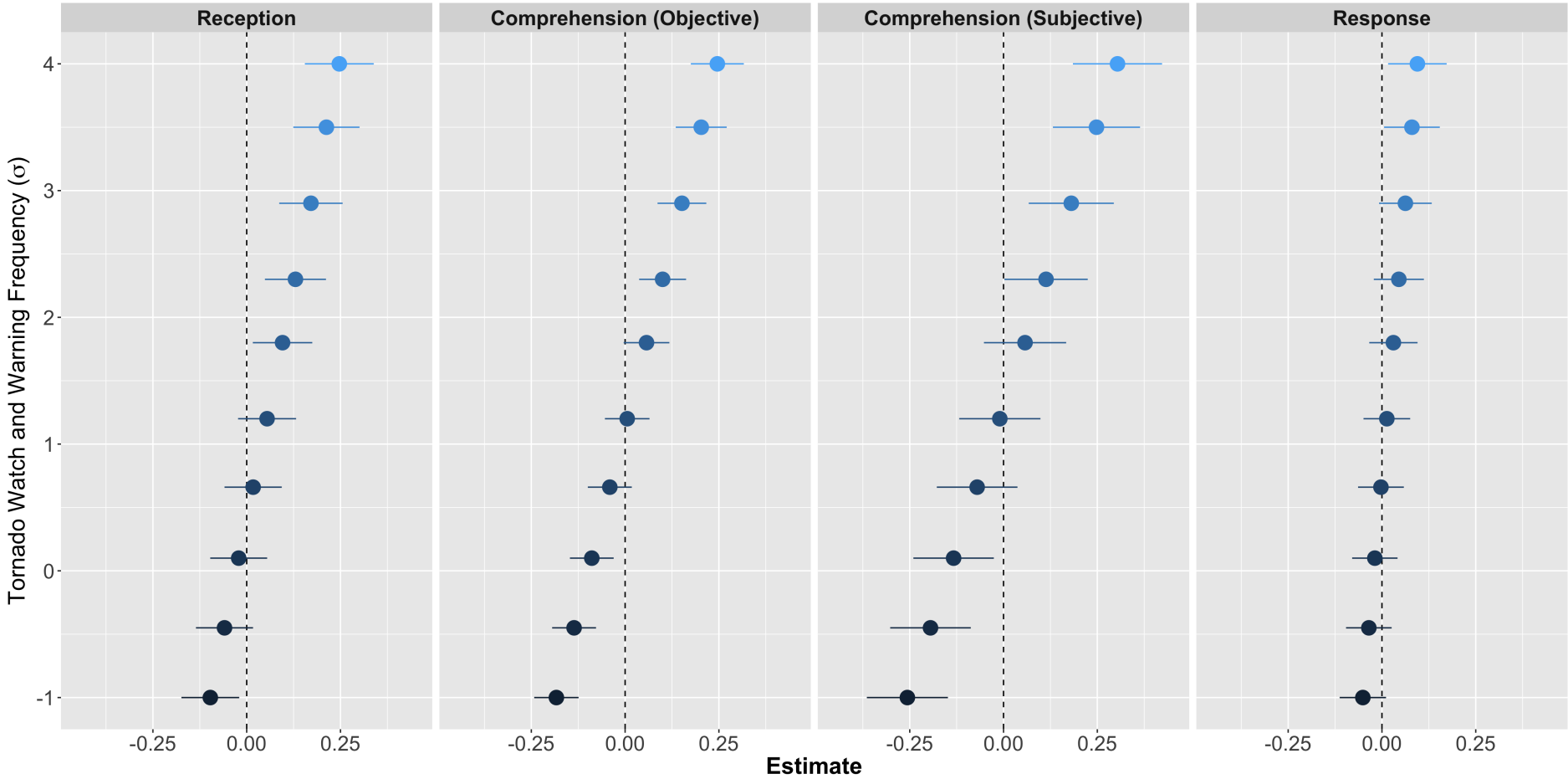
Local Area Estimation

- How can we disaggregate (downscale) these data to identify variation in reception, comprehension, and response across communities (CWAs)?
- Multilevel regression with poststratification (MRP)
  1. Estimate multilevel regression models that predict the composite scales as a function of demographic and geographic variables
  2. Use this information (the parameters from these models) to estimate mean composite scores for each CWA

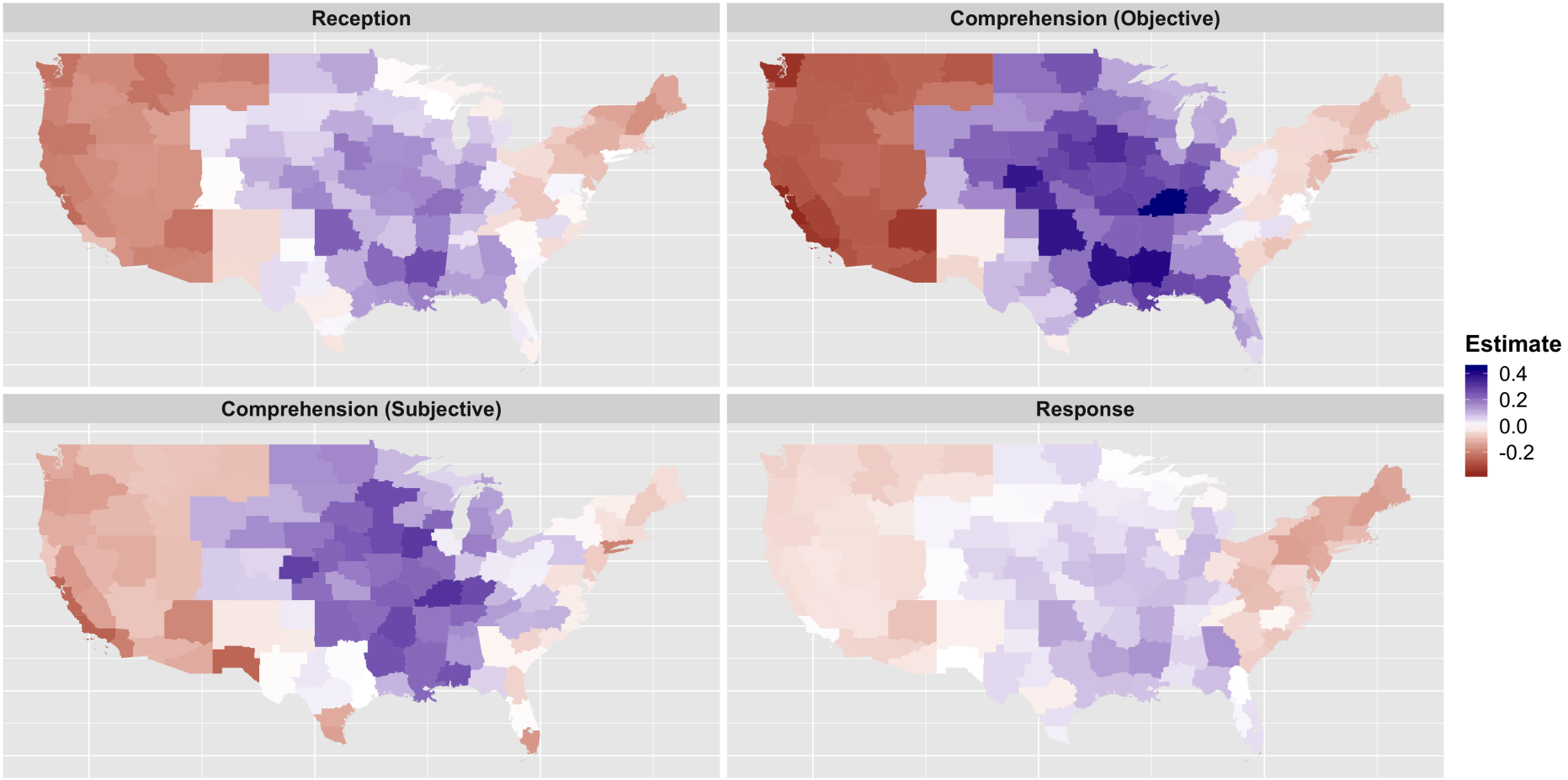
Multilevel Regression Models (Parameters)



Multilevel Regression Models (Parameters)



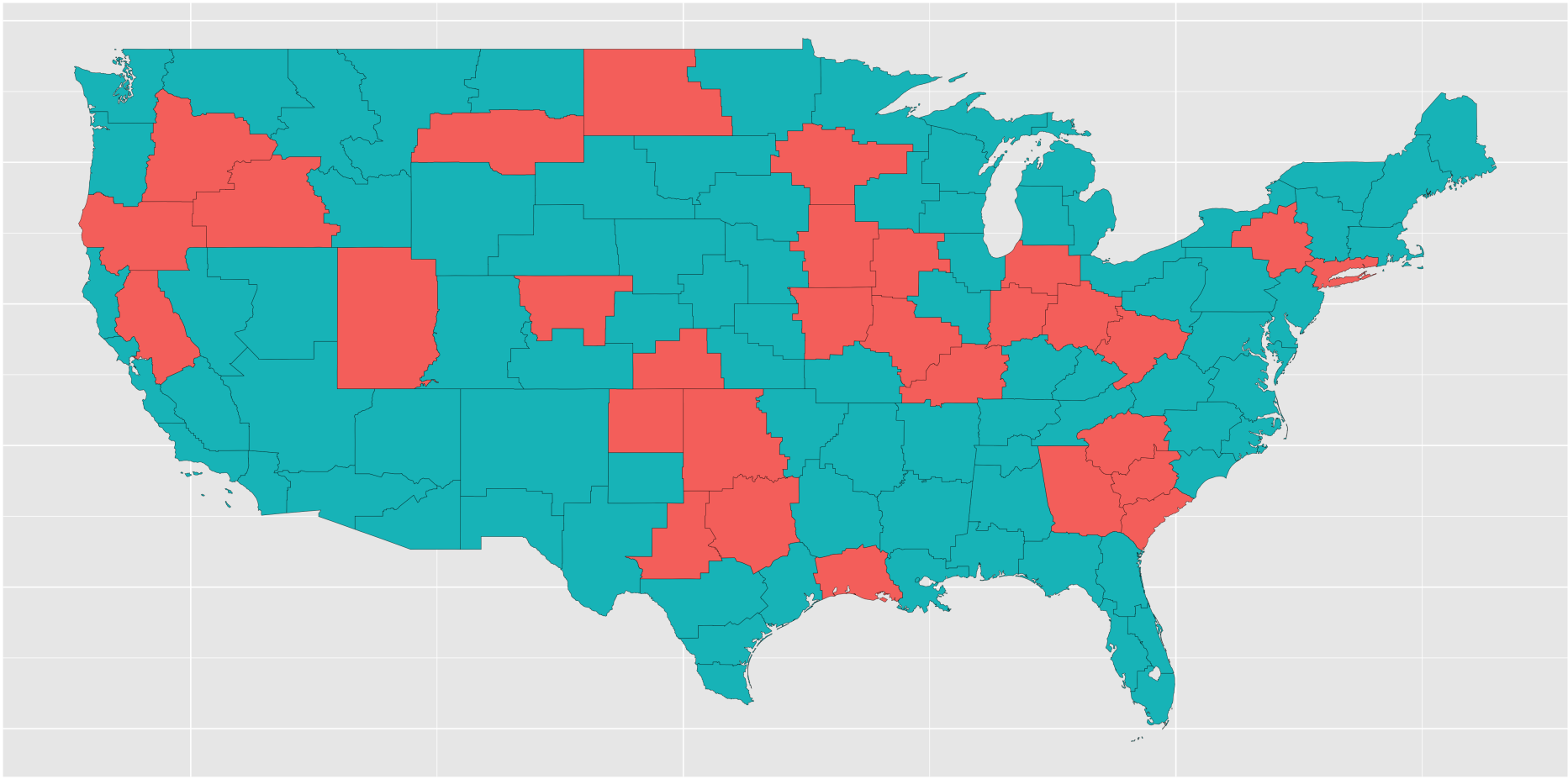
Mean Composite Scores by CWA



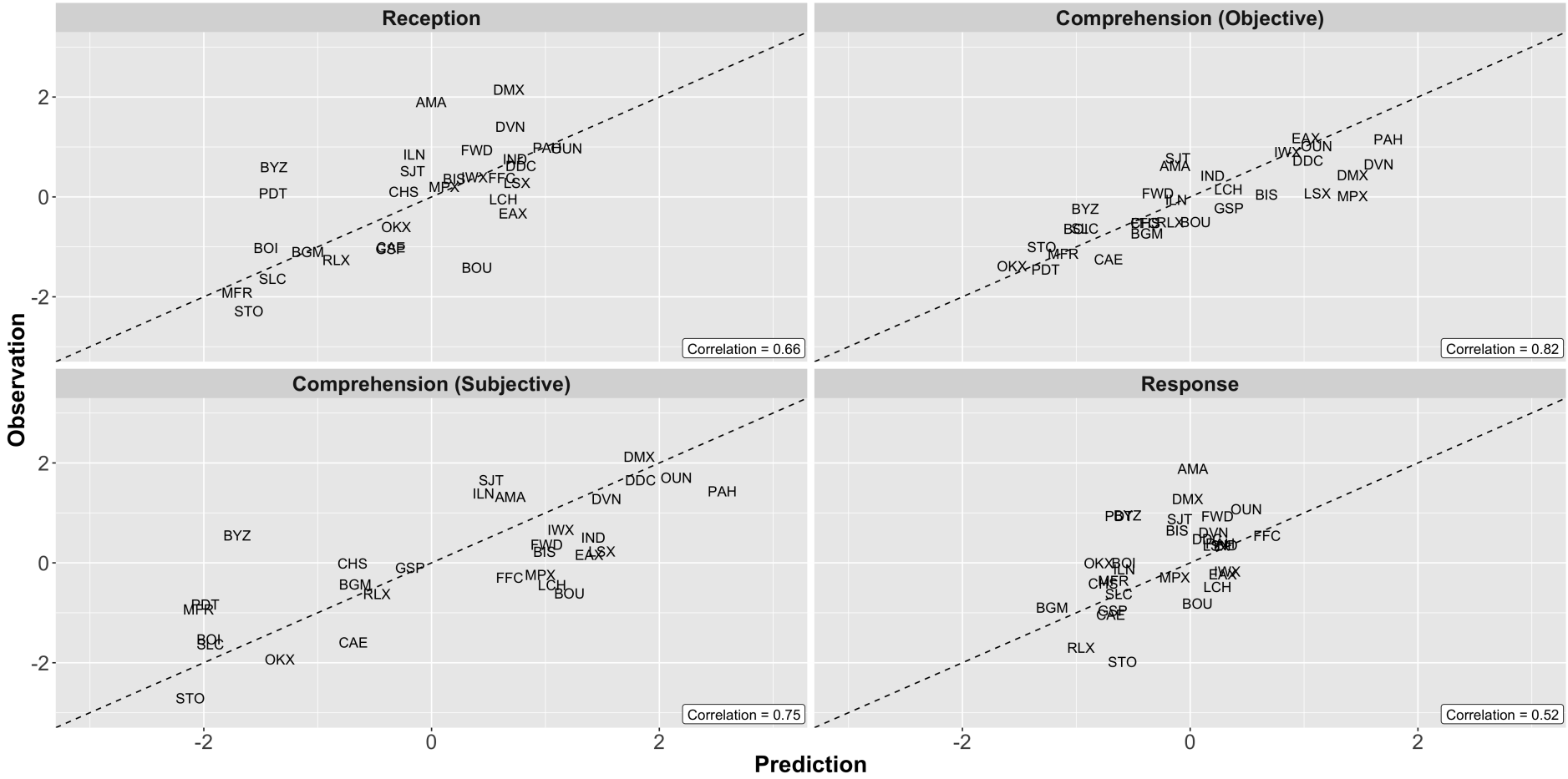
Validation

- How do we know if the estimates are accurate?
- Validation Survey:
  - Random sample of 30 CWAs
  - ~50 adults from each CWA
- Compare observations from the oversample in each CWA to the MRP predictions (estimates)
  - If the estimates are accurate, there should be a relatively high correlation between the predictions and observations

Validation (Random Sample of CWAs)



Validation Results



Conclusions and Next Steps

- We have reliable estimates of tornado warning reception, comprehension, and response that show considerable variation across CWAs
- Now, we are working to:
  1. Refine and calibrate the estimates (especially the "response" estimate)
  2. Identify the factors that explain this variation
     - WFO practices/culture?
     - Media market?
     - Characteristics of the community?
  3. Develop a WDTD training tool (and course) that will allow NWS forecasters and partners to interact with this information
  4. Expand this methodology to other hazards (flooding, winter, tropical)

Conclusions and Next Steps

Select a Measure:

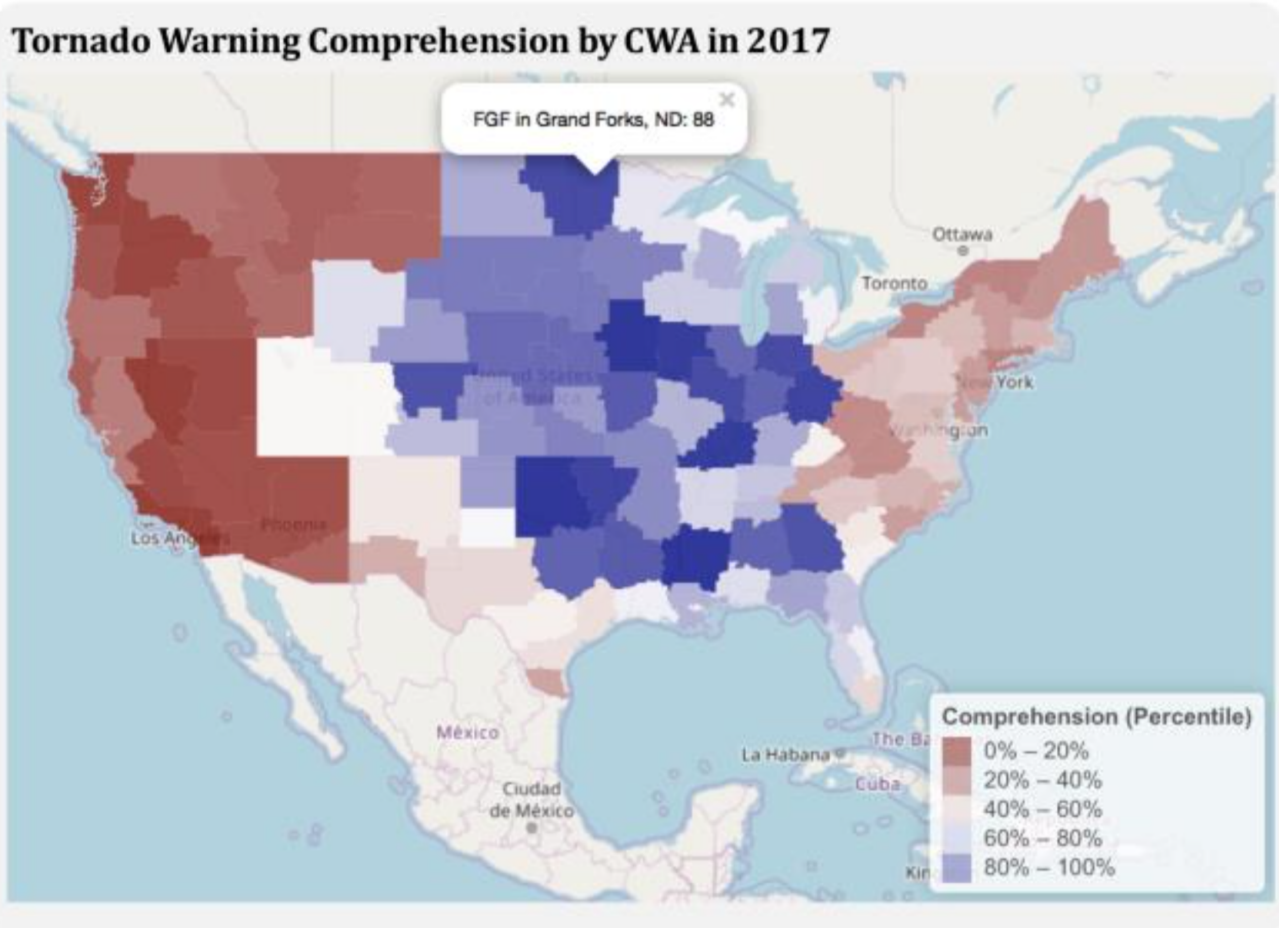
- **Warning Comprehension** ▲
  - Risk Perception
  - Warning Reception / Awareness
  - Warning Comprehension
  - Warning Response
  - Hazard Knowledge
  - Hazard Preparation

Select a Geography:

- **County Warning Area** ▲
  - State
  - County Warning Area
  - County

Select a Group:

- **All groups** ▲
  - All groups
  - Age: 18 to 24
  - Age: 18 to 34
  - Age: 35 to 50..



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- Questions? Contact:
  - Joe Ripberger (jtr@ou.edu)
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