

A Vision Science Approach to Uncertainty Visualizations

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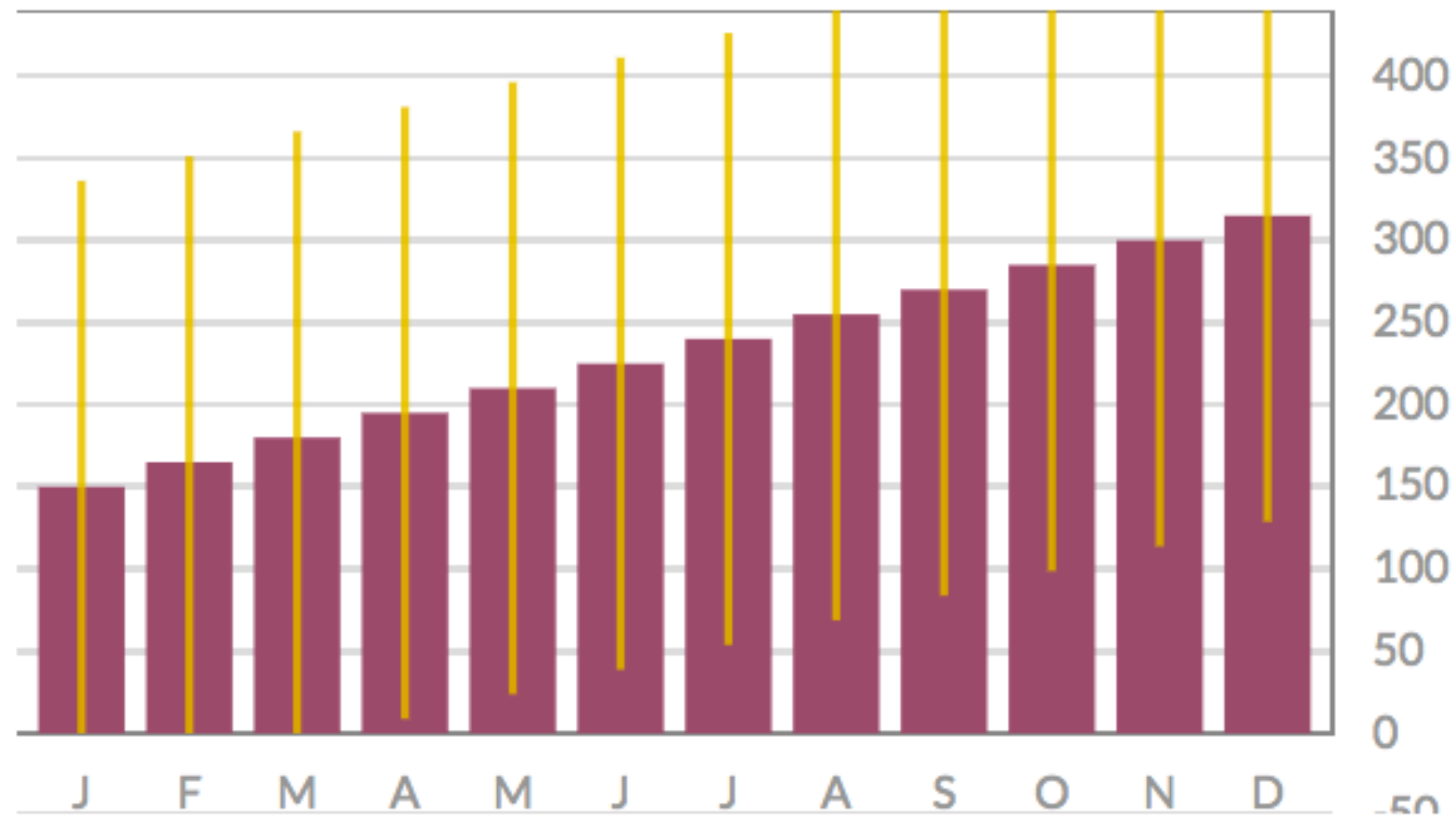


Motivation

- Probability and random sampling are at the heart of science and statistical inference
- Common visualizations of uncertainty lead to misinterpretations
 - i.e., Error bars

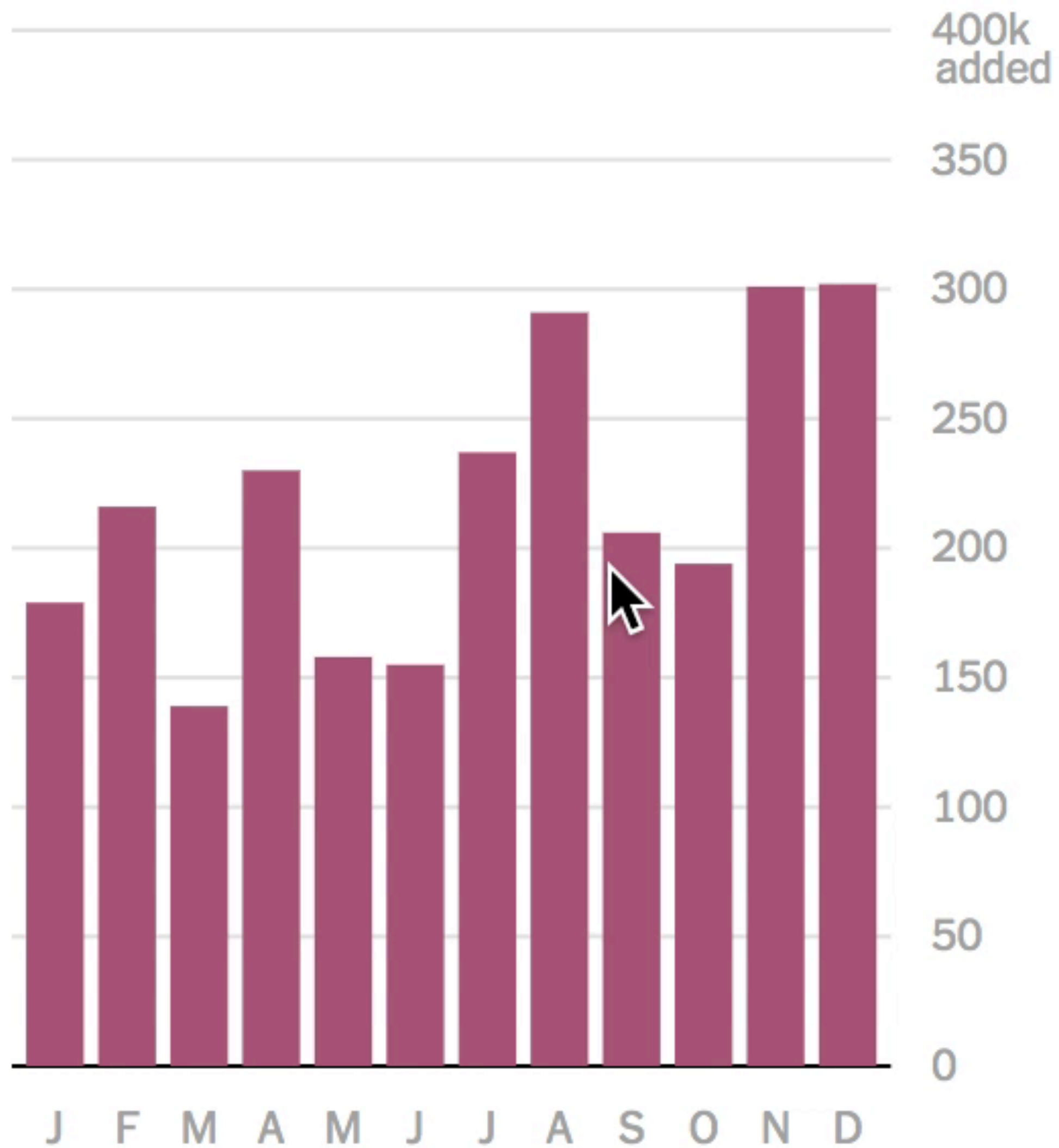
Error Bars

If job growth had been accelerating over the last 12 months...



- What do the error bars represent?
- Cognitive biases:
 - w/in the bar
 - Attention on point estimate

Dynamic Sampling Visualizations



- Encode uncertainty as frequency over time
- Well matched to ensemble processing capabilities of human visual system

Experiment

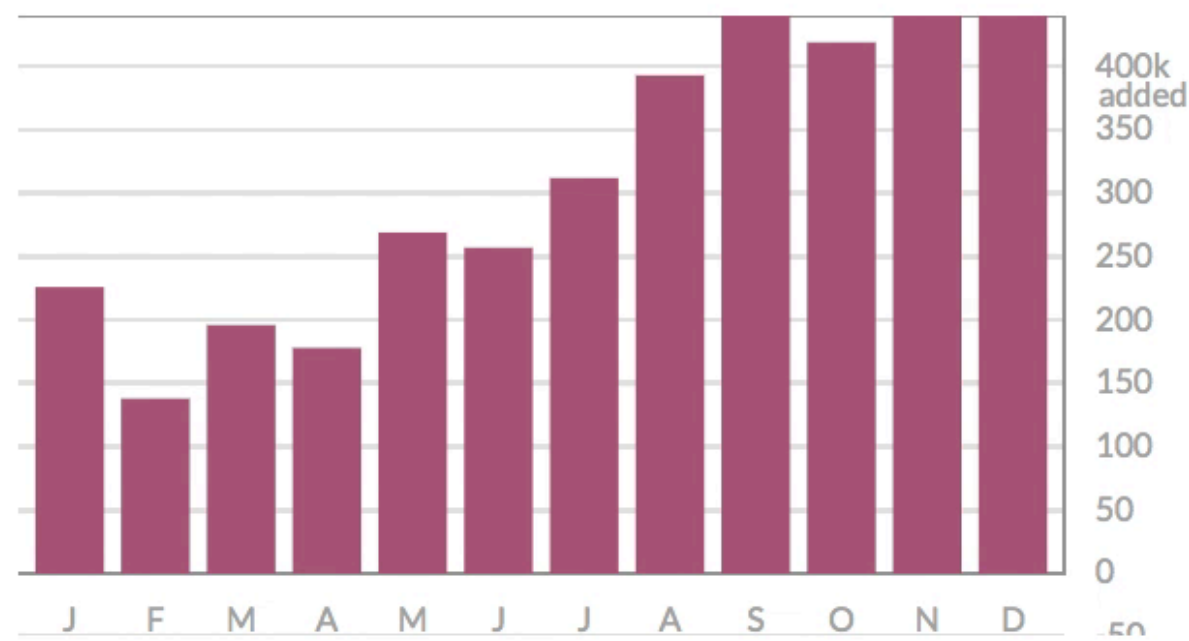
Task: Interpret Monthly Job Reports To Choose Newspaper Headlines

You will now examine charts showing monthly job numbers for a year, one at a time. You will choose which headline is the most appropriate for each case from the two headlines (which are visualized in charts) on the right side of the screen.

There are 60 charts to judge total.

After you submit your responses, we will randomly select 15 of your answers and calculate whether you chose the right headline. You will receive **\$0.20 per correct response as bonus, up to \$3.00 total.**

Qa: Given the data on the chart, which headline would you assign?



If job growth were actually steady over the last 12 months...



Latest Jobs Data Show No Growth

If job growth had been accelerating over the last 12 months...



Latest Jobs Data Show Growth Trend

Qb: How confident are you in your accuracy of your answer?



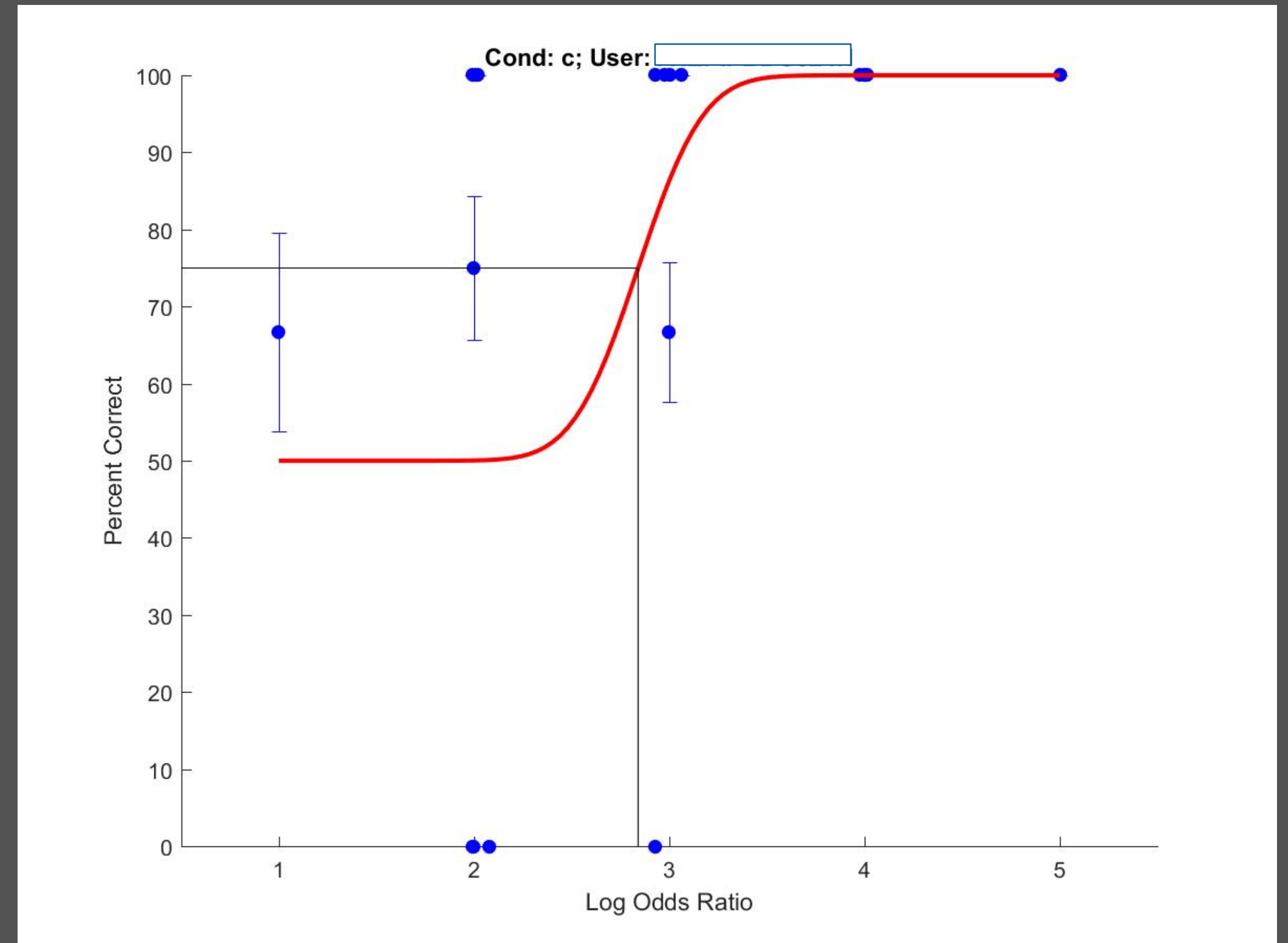
Pause

Continue

Research Questions

How do uncertainty visualizations affect:

- Sensitivity to a trend in noisy data?
 - i.e., ability to discriminate growth trend in jobs report despite sampling error
- We use **psychometric functions** to estimate:
 - Threshold = Mean of cumulative Gaussian
 - Perceptual Noise = SD of cumulative Gaussian



Research Questions

How do uncertainty visualizations affect:

- Metacognitive impressions of ability to comprehend display?
 - We model expected confidence per trial:
 - Monte Carlo simulation, given a range of odds ratios and perceptual noise
 - Expected confidence = percent of simulated trials correct at given odds ratio
 - “Confidence fitness”: describes the correspondence between reported and statistical confidence

Contributions

Methods from Vision Science

- Perceptual sensitivity and “confidence fitness” address underlying mechanisms

Dynamic Sampling Visualizations

- Defy conventional thinking about effectiveness of animations
- Cognitively natural approach to uncertainty visualization