How complex can the 'shape' of expectations be? Investigating error distributions under skewed priors.

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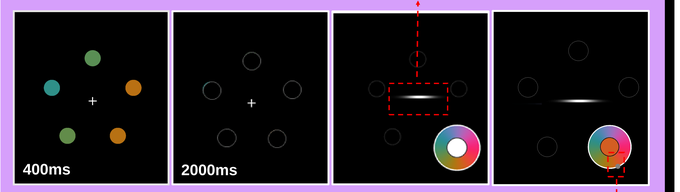
Question: How sensitive are people to complex-shaped priors, and can they be cued in a trial-by-trial manner?

1) Real world distributions can be complex and non-Gaussian, but previous research claims that people make Gaussian approximations
(Dakin & Watt, 1997; Rosenholtz, 2001)

2) Sensitivity to skewed distributions demonstrated only in priming studies
(Chetverikov, Campana, & Kristjánsson, 2016)

Paradigm

Expectations/priors are cued at response

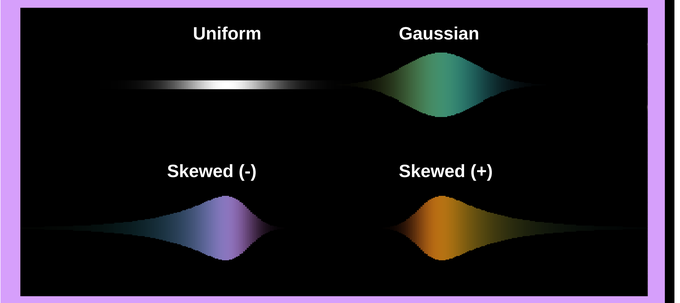


On each trial, we measure:

- **Error (reported color – target); further broken down***
  - Bias (how much the error is towards the *mu* of the prior)
  - Precision (spread of the error after correcting for bias)
- **Confidence**
  - Participants were asked to provide a spread of across the reported color

* Breakdown was done model-free; model-based methods (*memToolbox*) yielded similar results

Conditions / Prior cues

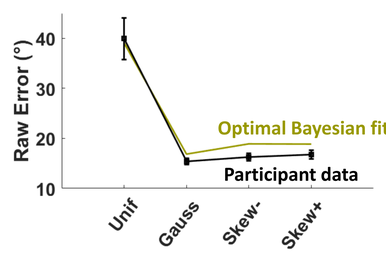


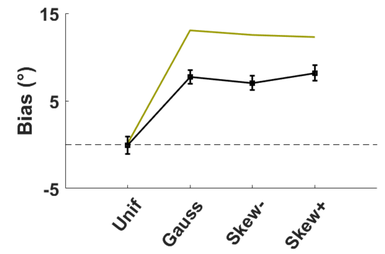
1) Cue type and mode/*mu* randomly selected per trial

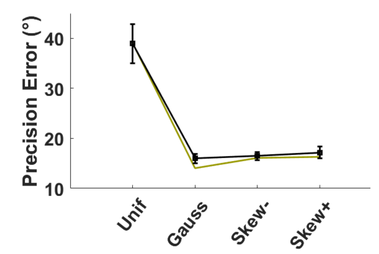
2) Height of color indicate relative probability

Experiment 1: Differences between Gaussian and Skewed Priors (stimuli sampled from cued prior)

1) The cues were effective: The non-uniform priors all caused biases in responses towards the *mu*, as well as increasing precision (reduction in spread of errors)

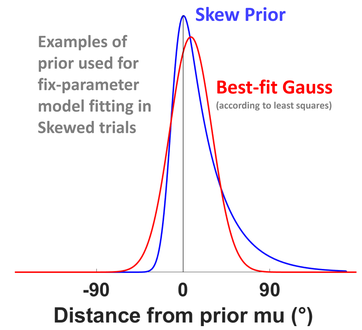


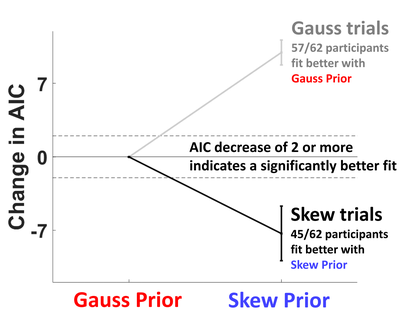




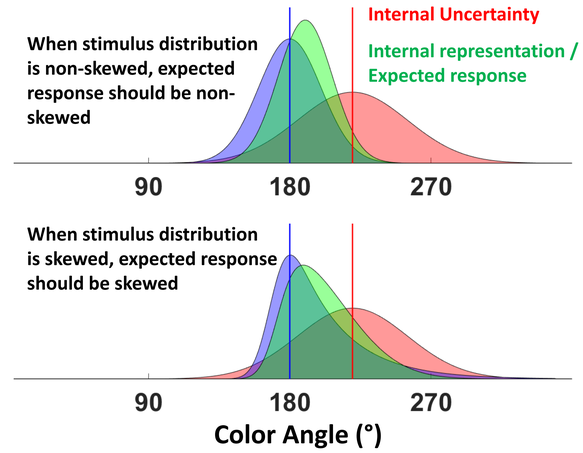
2) Participants incorporate skew information, rather than make Gaussian approximations

- Fits are used to infer participants' priors from error distributions
- Results are similar for fixed and free-parameter versions of the model
- Free-parameter model also accurately recovers the parameters of the Skew and Gauss distributions used in-experiment





Model fitting



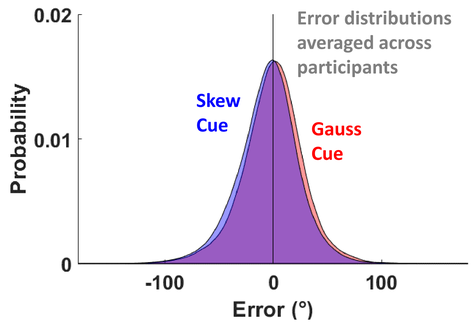
Model assumptions:

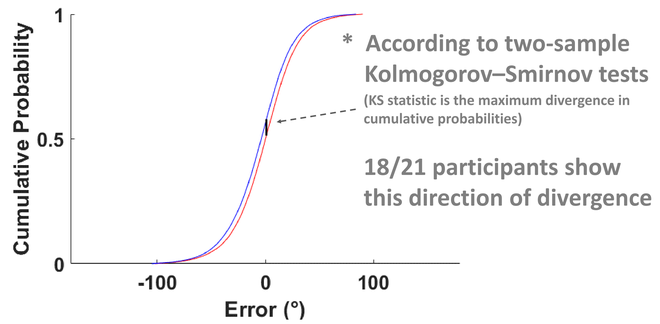
1) Internal uncertainty (estimated from Uniform trials) is relatively stable across trials
2) Expected error distribution across trials is the sum of expected error distribution for each trial
3) Internal representation on any given trial is a Bayesian convolution of the prior and internal uncertainty

Experiment 2: Differences between Gaussian and Skewed Expectations (stimuli sampled from skewed distributions)

1) Changes in the report distributions are not due to changes in stimulus distribution

2) Shape of cue communicated to participants changes the shape of error distributions





General Conclusions

1) People are sensitive to and can utilize complex statistical information such as skew in their decisions

- This integration of statistical information happens in a Bayesian – or at least Bayesian-like – manner

2) These complex expectations are picked up quickly: Even a single cue is sufficient to impact the shape of error distributions

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