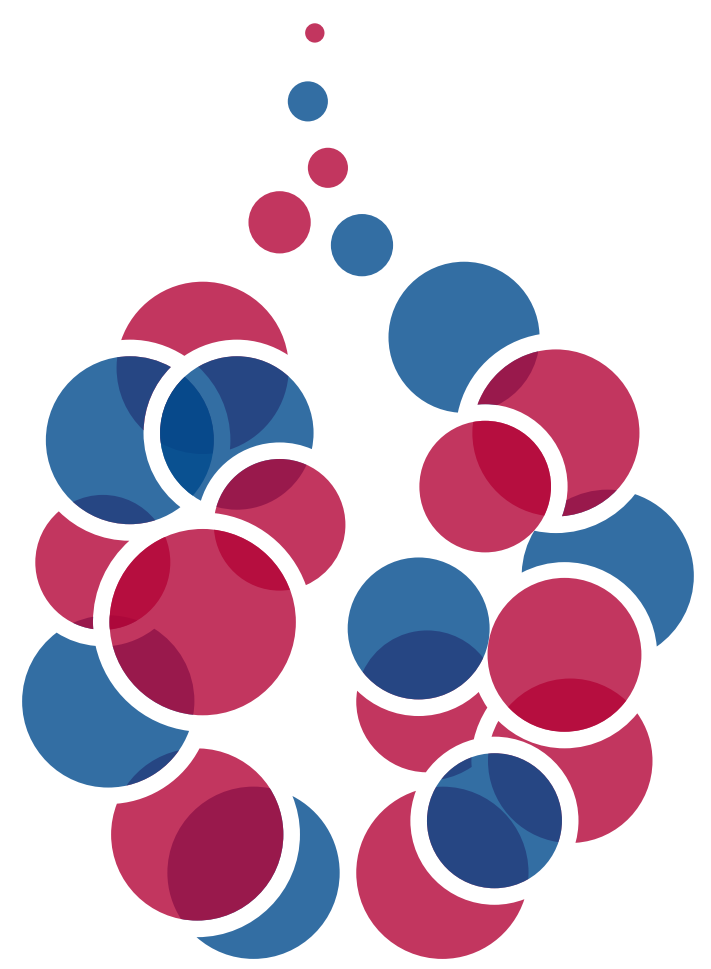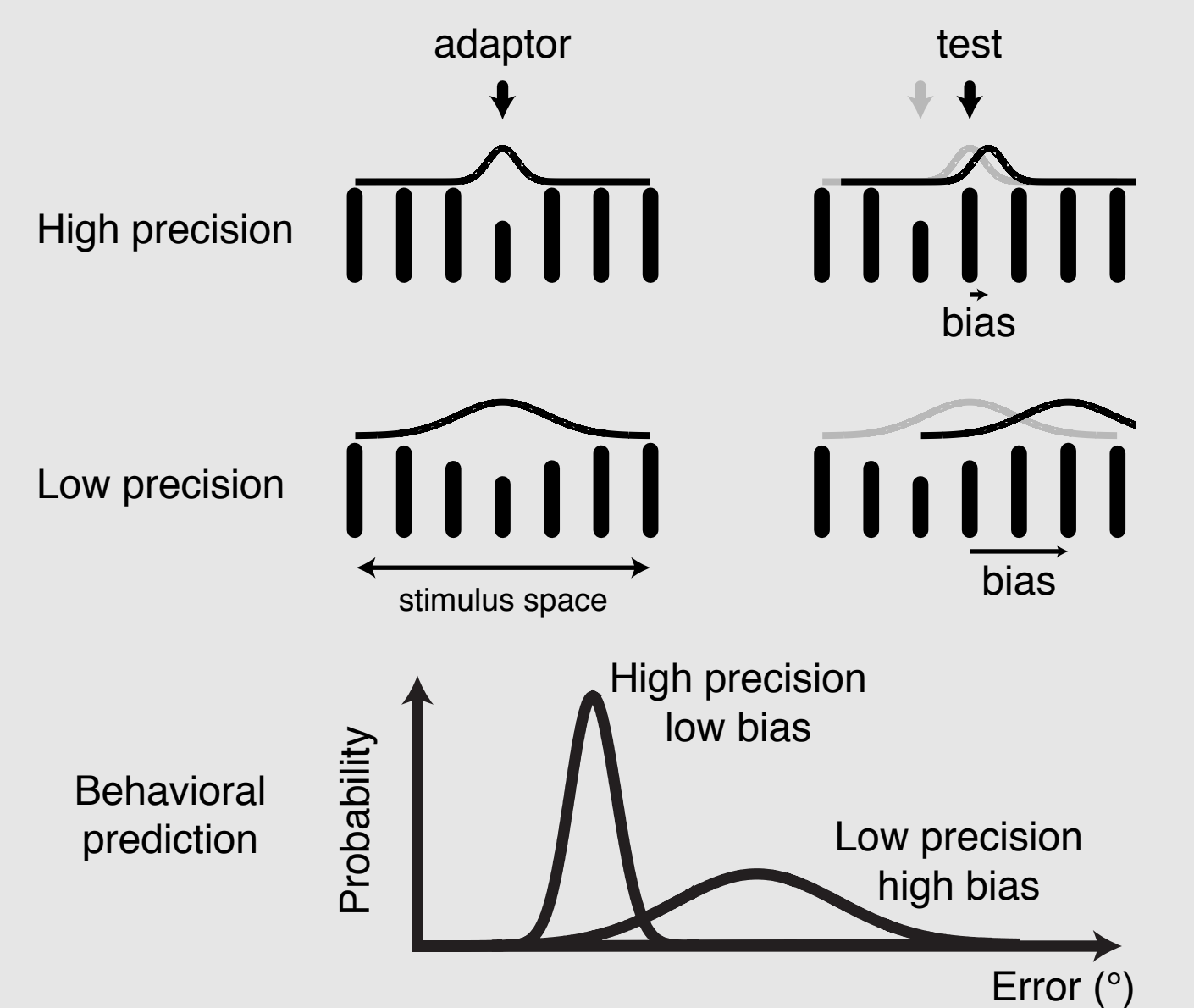# Individual differences in representation precision predict adaptation bias

Marcelo Gomes Mattar, Marie Carter, Marc Zebrowitz, Sharon Thompson-Schill, Geoffrey Karl Aguirre

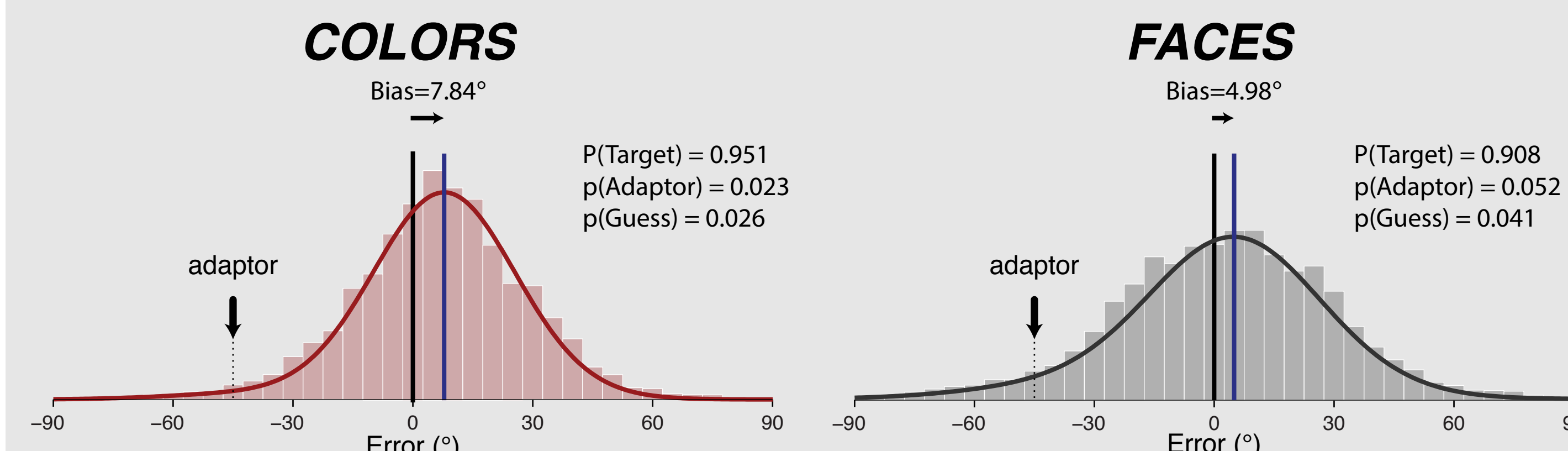*Center for Cognitive Neuroscience, University of Pennsylvania, Philadelphia, PA*

Introduction:

- The internal representation of visual stimuli is imperfect and subject to biases.
- Under a Bayesian framework, bias is expected to be greatest when representation precision is poor.
- Here, we investigate the relationship between precision and bias across:
 - Subjects
  - Time
  - Stimuli

adaptor / test

High precision — bias
Low precision — bias

stimulus space

Behavioral prediction
High precision low bias
Low precision high bias
Probability / Error (°)

Methods:

COLORS   **FACES**

Trial structure

- 5s - adaptation
- 100ms - mask
- 100ms - target
- wait for click
- response

- Experiments were conducted online: http://cfn.upenn.edu/iadapt
- 400 participants recruited from Amazon Mechanical Turk
- Stimuli were COLORS or FACES drawn from a circular distribution
- Participants completed two (Dataset 1) or six (Dataset 2) blocks of 30 trials each
- Each trial consisted of 5s of adaptation, followed by a 100ms mask and a 100ms target
- Responses were entered using a color/face wheel
- Adaptors were offset by +45°/-45° from the target
- Two additional tasks were performed: an immediate stimulus-match (15 trials in two blocks), a 5s delayed match (30 trials in two blocks)
- Participants were excluded based on:
  - Color blindness (Ishihara test)
  - Poor of understanding of instructions
  - Poor performance in any block
  - Incomplete data

Model fitting

- Distribution of errors (response-target) was fit by a mixture of three distributions
  - Uniform distribution (account for guesses)
  - Von Misses distribution centered at adaptor location
  - Von Misses distribution centered at 0°+*BIAS*, maximizing fit log-likelihood
- Parameters extracted from each block/subject:
  - Bias: center of target Von Misses
  - Precision: inverse of circular standard deviation

adaptor / Error (°)

Results:

Dataset 1 [n=202 observers]

COLORS Bias=7.84°
P(Target) = 0.951
p(Adaptor) = 0.023
p(Guess) = 0.026
adaptor / Error (°)

FACES Bias=4.98°
P(Target) = 0.908
p(Adaptor) = 0.052
p(Guess) = 0.041
adaptor / Error (°)

Response bias induced in both face and color data

Is precision a stable property of the observer?

Precision adaptation experiment vs Precision in matching experiment — r=0.44 (COLORS), r=0.45 (FACES)
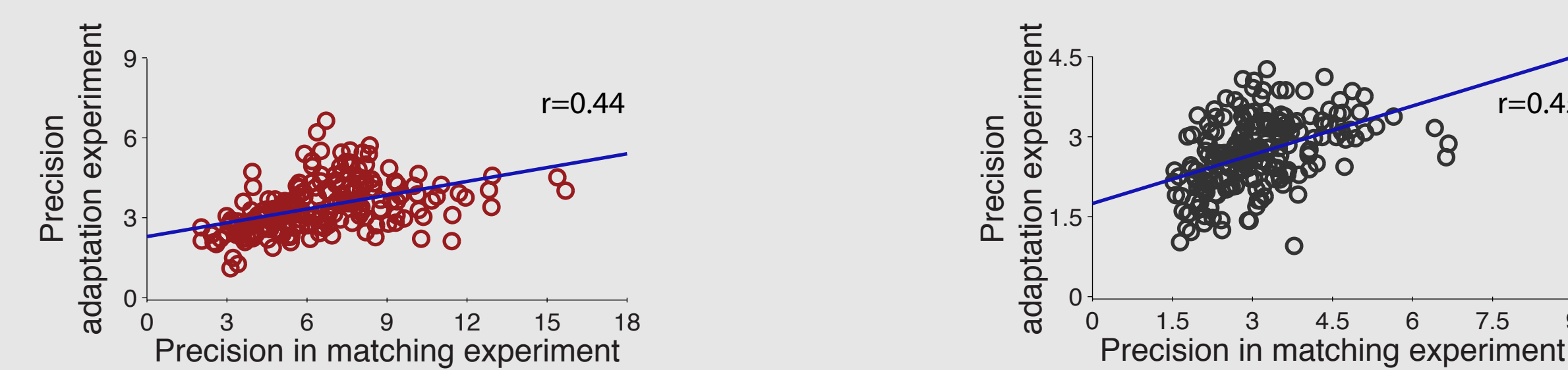
What is the relationship between representation precision and adaptation bias?

Bias (deg) vs Precision (deg⁻¹): Spearman's rho=-0.26 (COLORS), Spearman's rho=-0.13 (FACES)
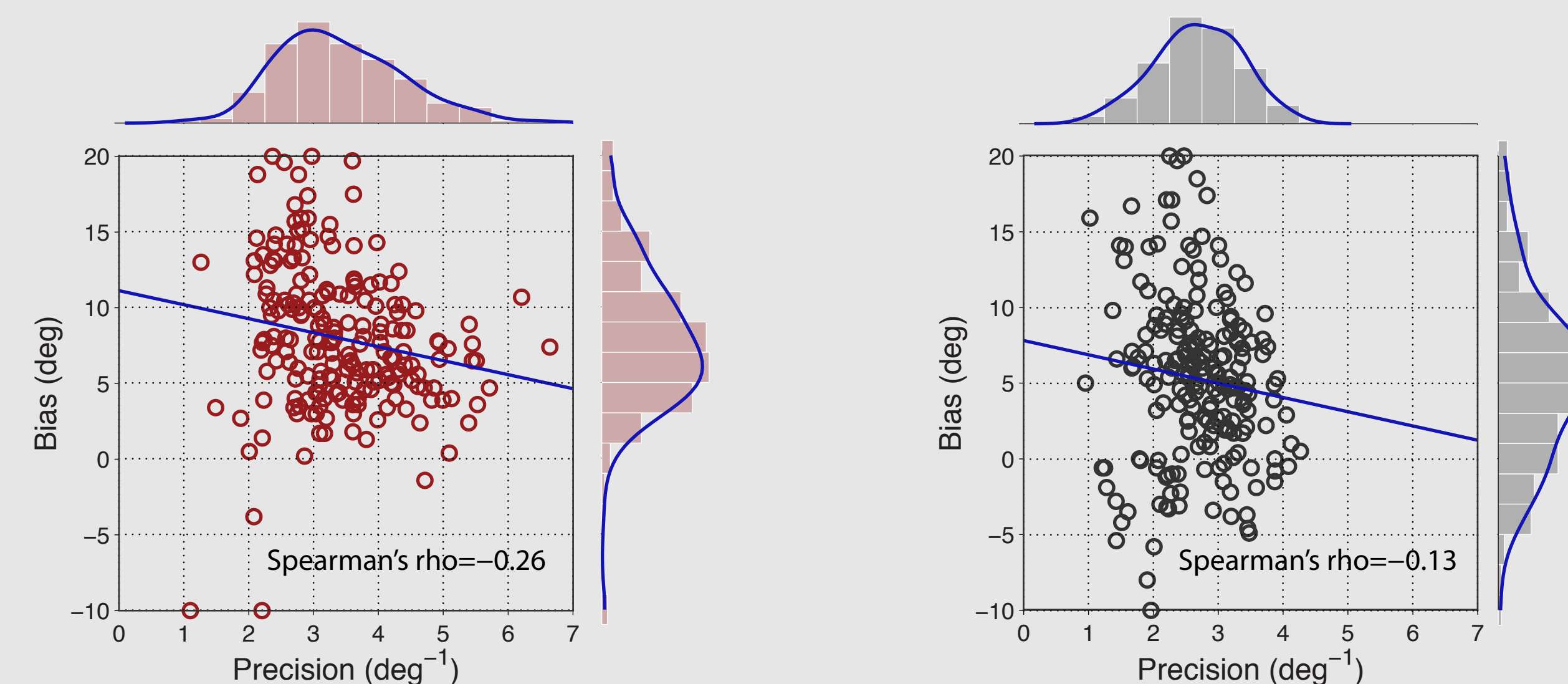
Representation precision is negatively correlated with adaptation bias.

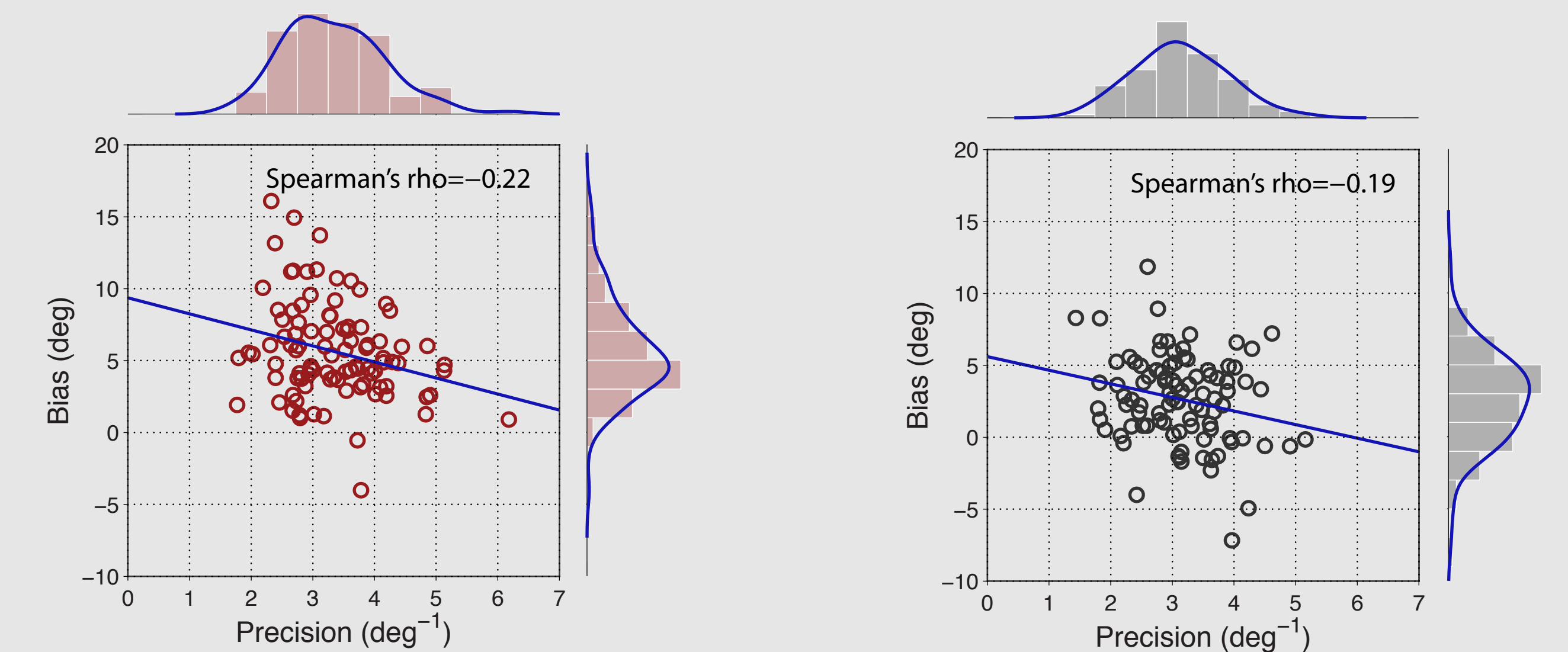**Is individual variation in bias and precision stimulus specific?**

Face Precision (deg⁻¹) vs Color Precision (deg⁻¹): r=0.57
Face Bias (deg) vs Color Bias (deg): r=0.22
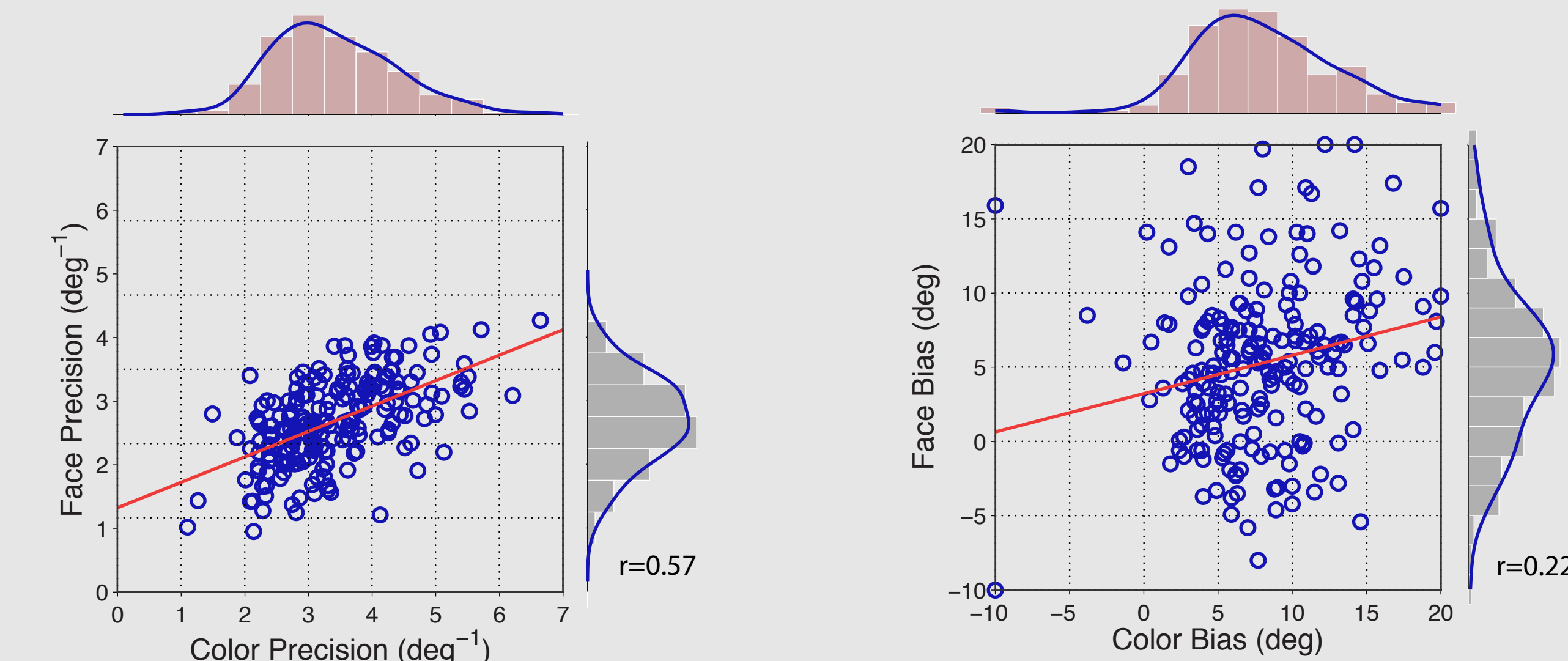
Variance is shared between stimulus category

Results:

Dataset 2: high saturation [n=97 and n=94 observers]

Does the relationship replicate with new stimuli?

Bias (deg) vs Precision (deg⁻¹): Spearman's rho=-0.22 ; Spearman's rho=-0.19

Variation across blocks (within subjects)

Average Spearman's rho=-0.33
t(95) = -4.95, p=0.0000

Average Spearman's rho=0.01
t(93) = 0.23, p=0.8152

Variation across stimuli

Bias (deg) vs Precision (deg⁻¹): Spearman's rho=-0.49
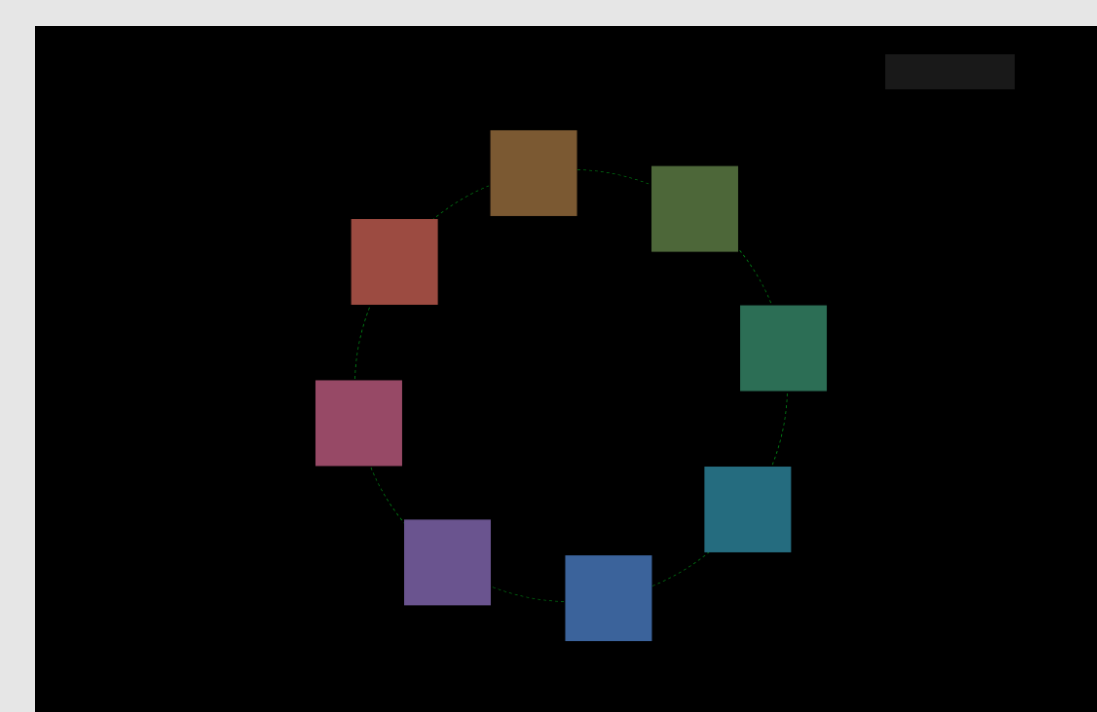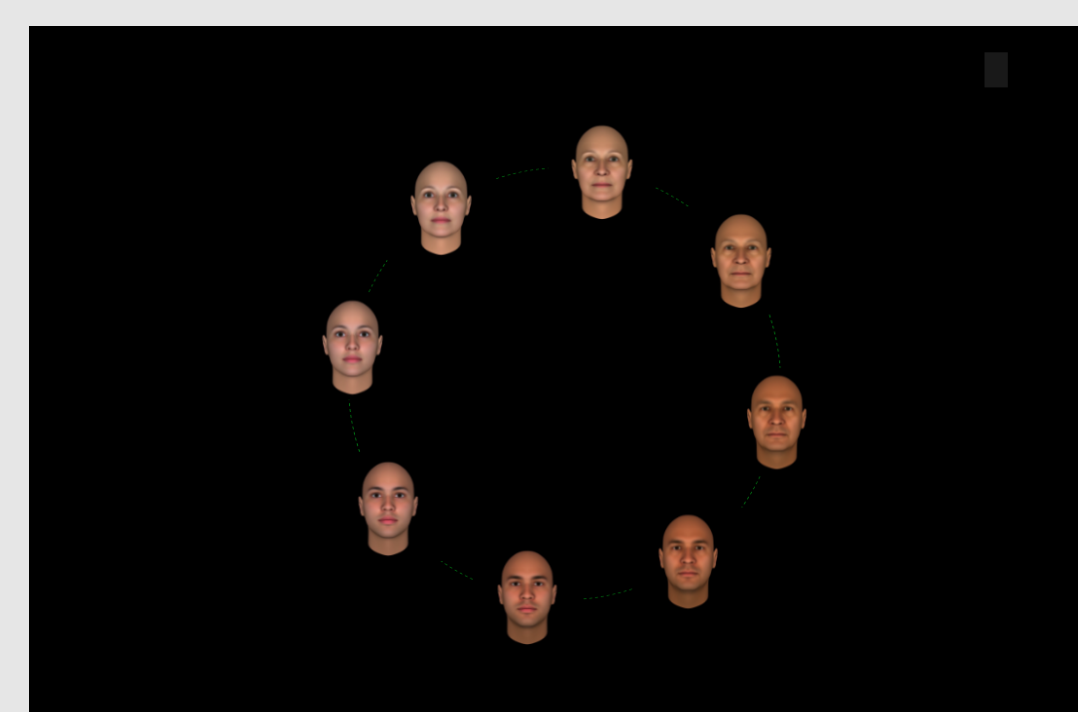error bars: ±SEM across trials

PENDING...

Conclusions:

- Precision of perceptual representations negatively predicts the magnitude of adaptation bias.
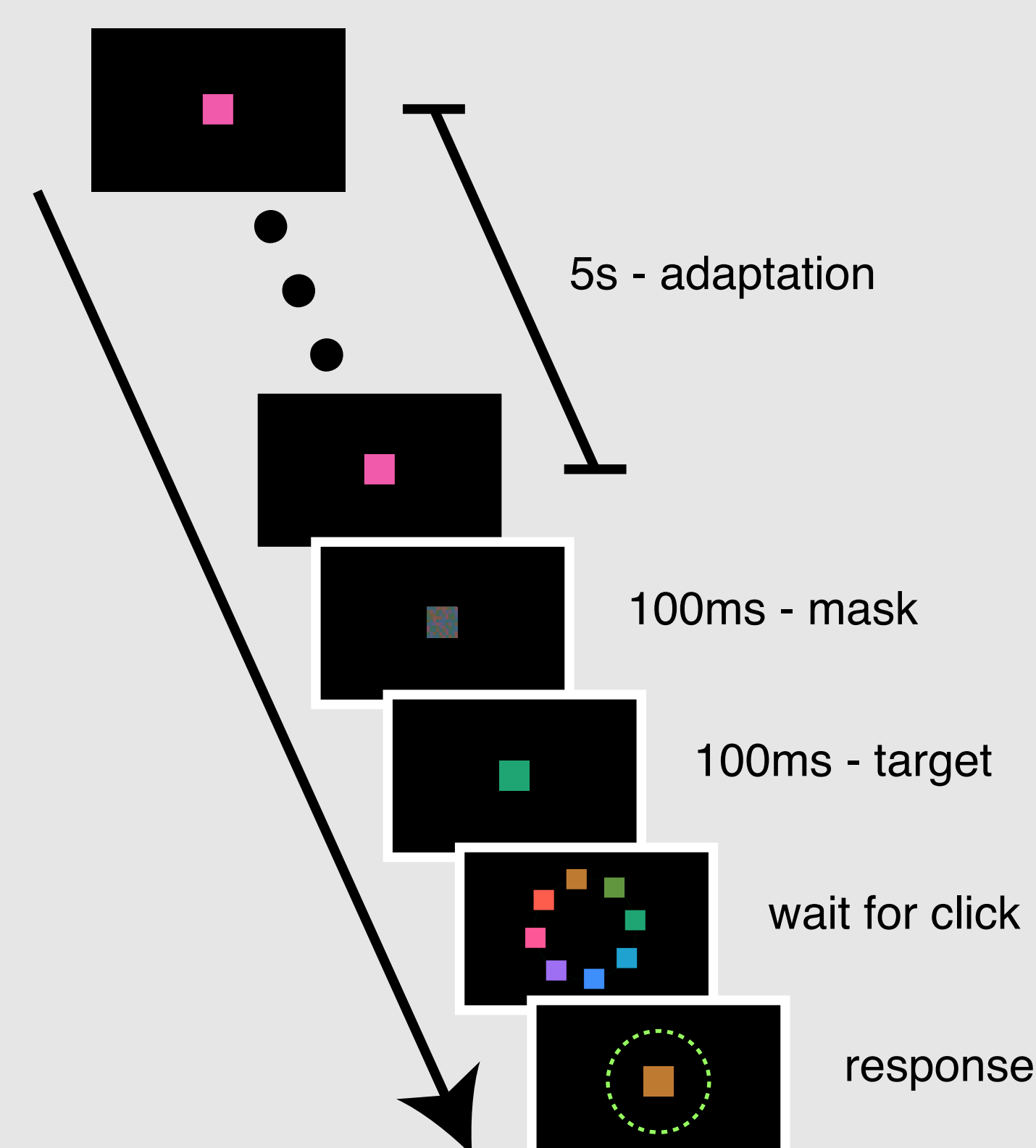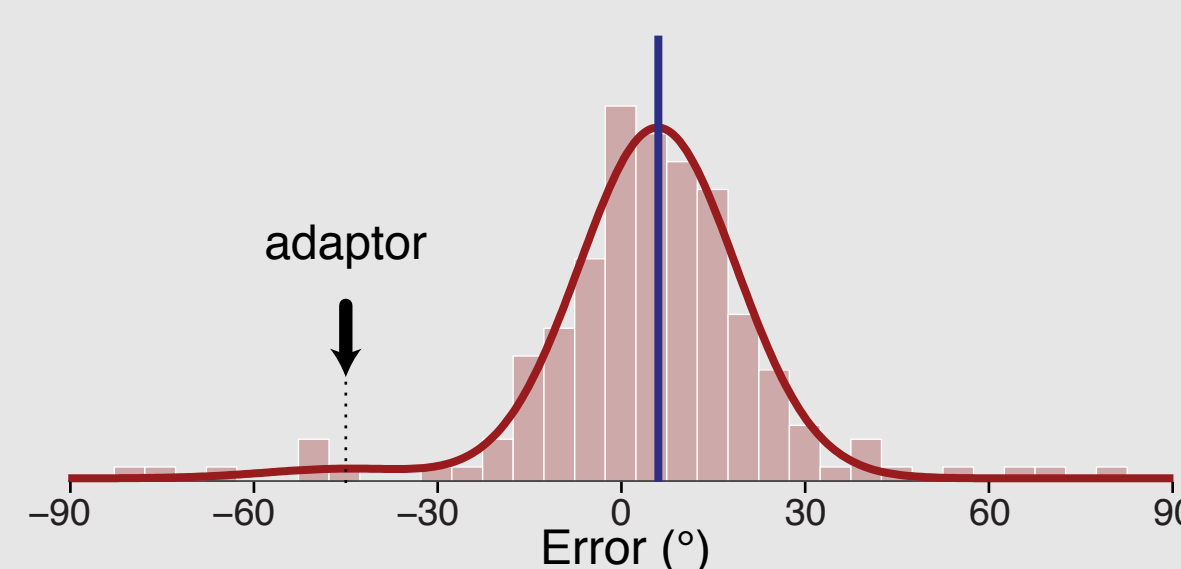- Under a Bayesian framework, this corresponds to a *PRIOR TO DIFFERENT STIMULI*.