CUEING RAPIDLY DEPLOYS TOP-DOWN INFLUENCES IN A MIXED SYMMETRY SEARCH TASK

Mary M. Conte and Jonathan D. Victor

Department of Neurology and Neuroscience, Weill Medical College of Cornell University, New York, NY

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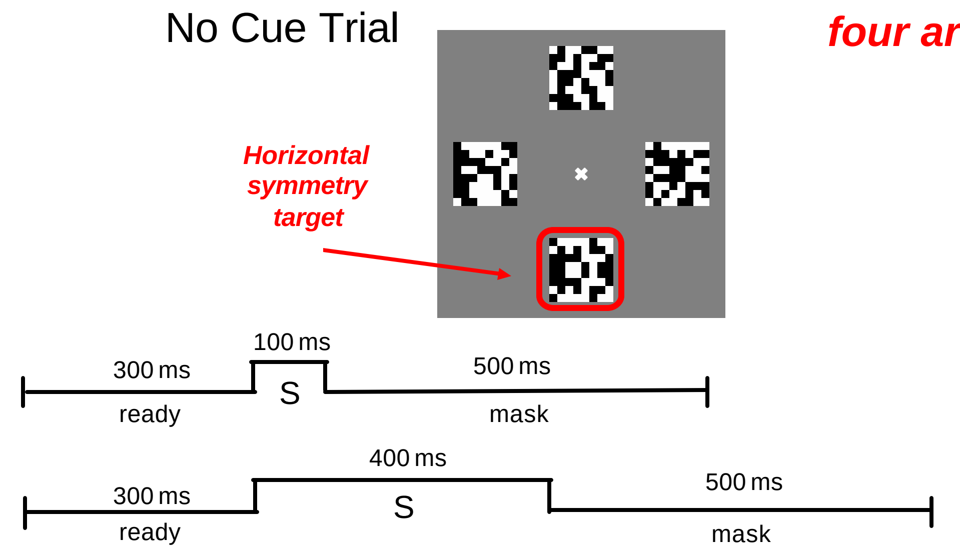
http://www-users.med.cornell.edu/~jdvicto/vps.html

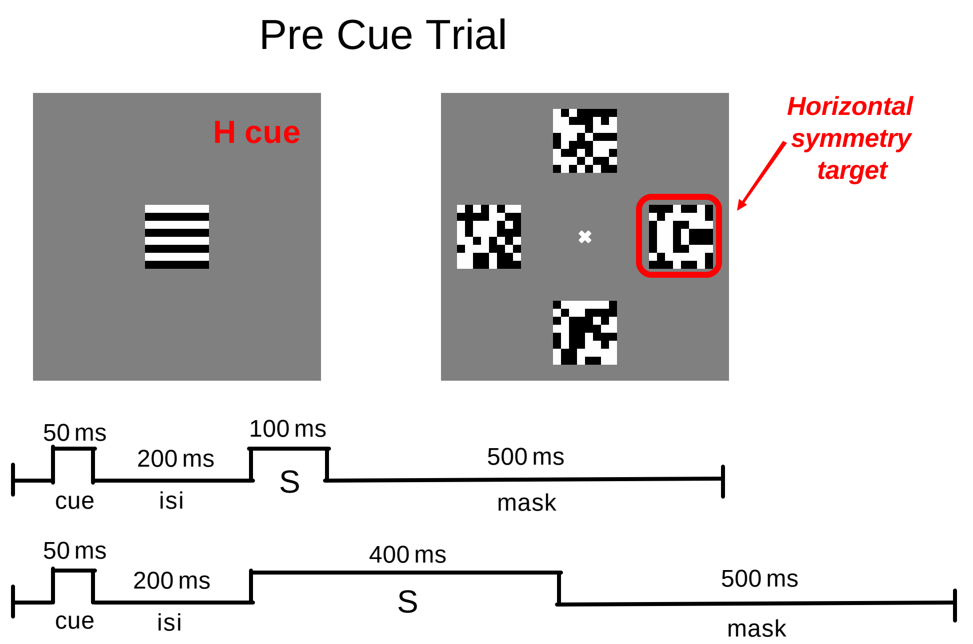
INTRODUCTION

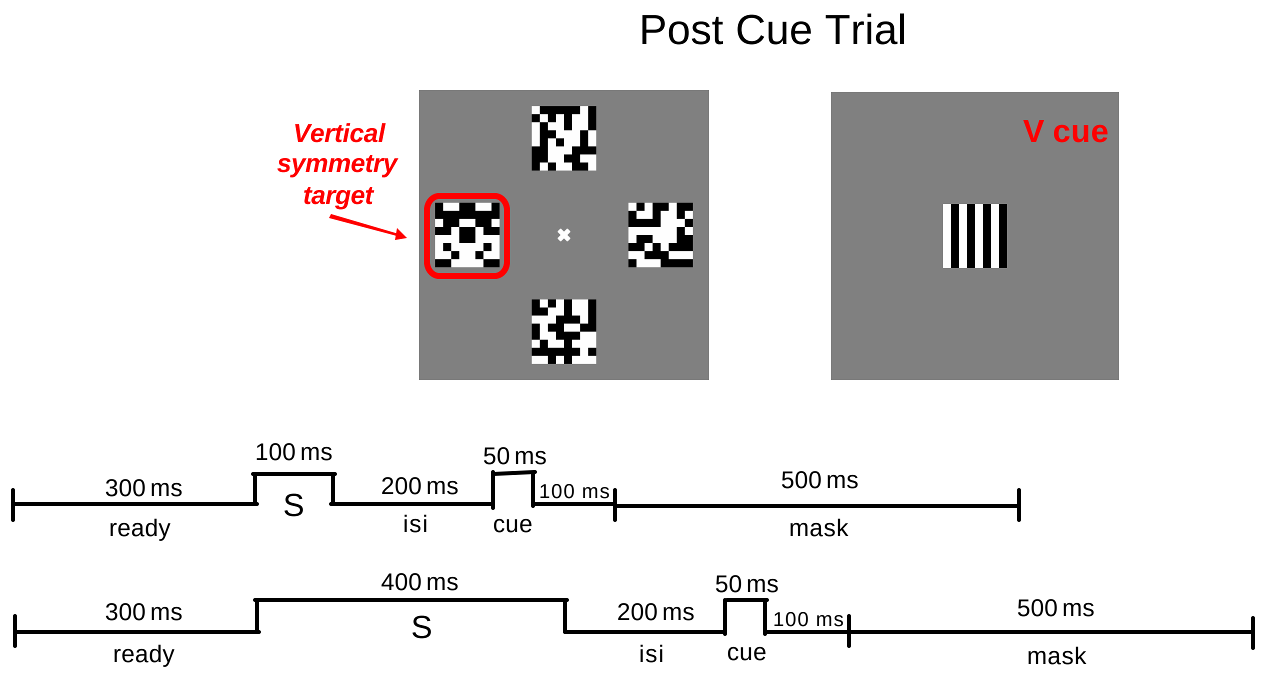
We recently showed that a subject's implicit knowledge of the direction of the symmetry axis biased the positions in which symmetry was detected. That is, when stimuli were presented in single-symmetry blocks, vertical symmetry was best detected on the vertical axis of the display and horizontal symmetry was best detected along the horizontal axis of the display. However, these biases were reduced when symmetry types were mixed within a block, thus implying a role of top-down influences. Here we investigate how explicit knowledge (cueing the direction of symmetry axis) influences these positional biases.

STIMULI & METHODS

TASK: Which one of the four arrays is different?







Stimuli consisted of four 8x8 arrays of black and white checks (check size: 20 min; test distance: 103cm) positioned 4 deg from fixation along the cardinal axes, and presented for durations of either 100 or 400ms.

The target array was bilaterally symmetric along either the horizontal (H) or vertical (V) axis. Distractor arrays were colored at random.

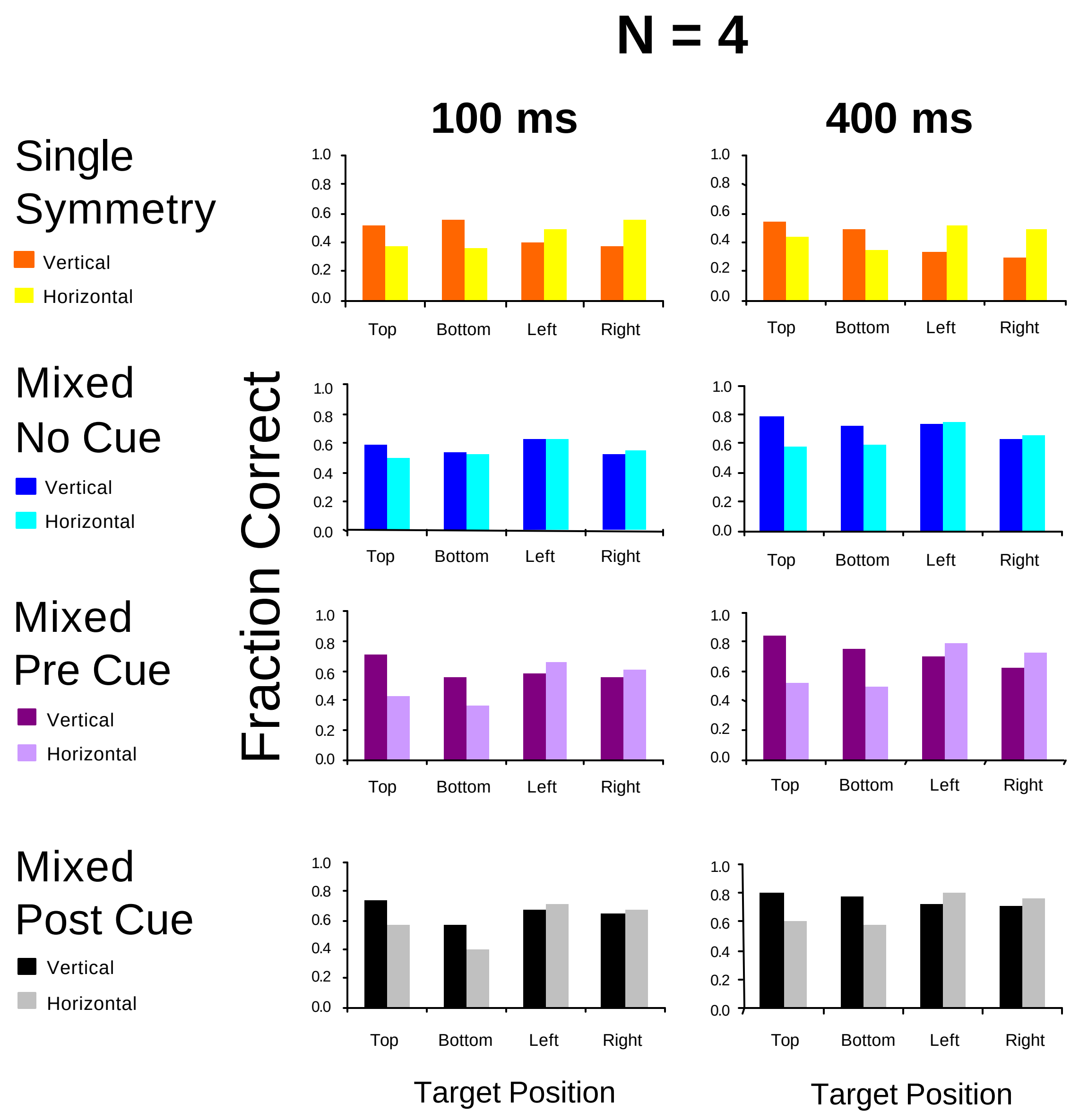
In a 4-AFC search task, four trained observers viewed these stimuli in single symmetry blocks (H or V), and in three randomly mixed (H & V) block conditions (No Cue, Pre Cue, Post Cue). Blocks consisted of 896 trials. Each observer completed 12 blocks for a total of 10,752 trials.

In cued trials, a vertical or horizontal grating was presented for 50ms at fixation to indicate target symmetry, but not target location. All trials were validly cued.

Half of the targets had perfect symmetry (as shown). The other half of the targets had symmetry degraded by 25%. All data shown represent averages over these two conditions.

other details:
Feedback during practice (1-2 hrs) only
Contrast: 1.0; Luminance: 47 cd/m^2
Cambridge Research VSG2/5 system

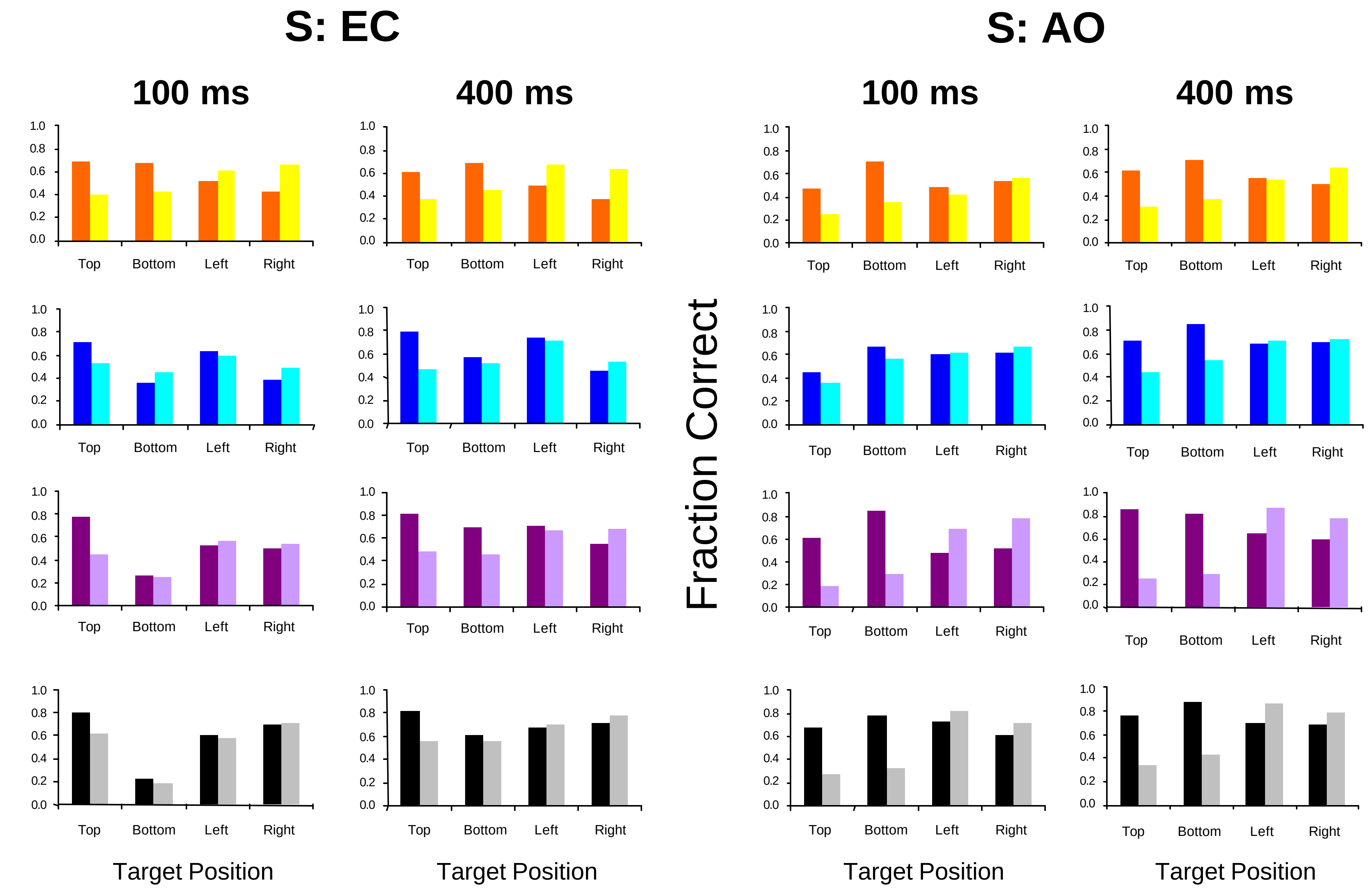
RESULTS



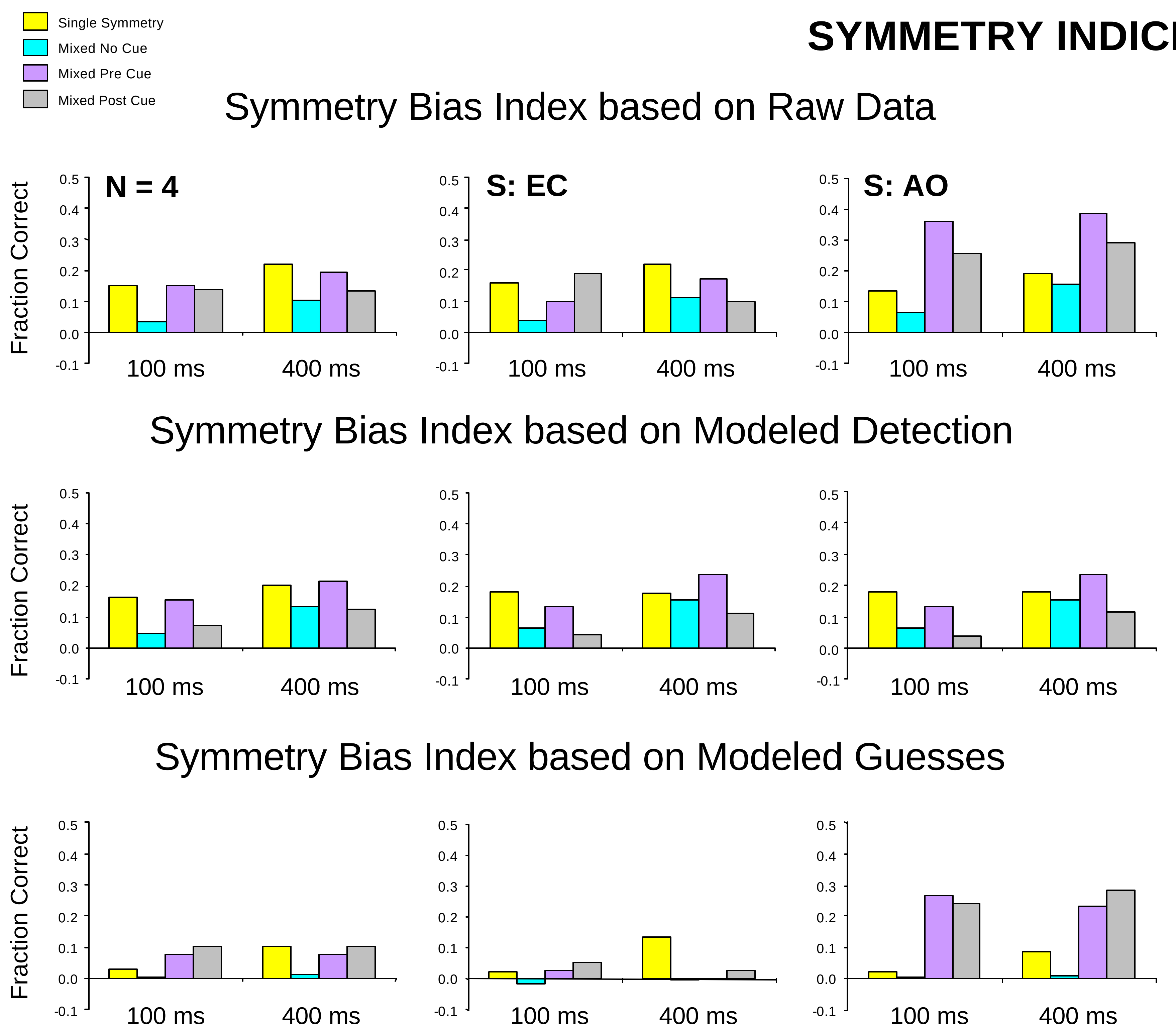
In the single-symmetry blocks, fraction correct depended strongly on target position. Horizontal symmetry was detected more frequently on the horizontal axis, and vertical symmetry was detected more frequently on the vertical axis. In addition, some subjects detected targets more frequently on the top than bottom, or more frequently on the left than right. Positional biases were larger at 400 ms than at 100 ms. In mixed blocks with no cue, there was almost no dependence of fraction correct on target position for 100 ms presentations, and a modest dependence on target position for 400 ms presentations.

With cueing, there was no change in overall fraction correct. In cued mixed symmetry blocks, the positional bias was similar to that of the single-symmetry blocks. The post-cueing data suggests that the cueing effect was not due solely to changes in attentional set or eye movements.

These interactions are summarized by the **Symmetry Bias Index**. Also, we use a simple model to distinguish between a dependence of detection on position ("detection bias"), and a dependence of the subject's guessing behavior ("guess bias").



SYMMETRY INDICES



The **Symmetry Bias Index** is the difference between the fraction correct when the target's symmetry axis matches the display axis, and the fraction correct in the off-axis positions.

Model-based Separation of Detection Bias and Guess Bias

The four parameters d_{top}, d_{bottom}, d_{left}, d_{right} represent the fraction of targets that are detected at each location. If the target is *not* detected, the subject guesses. The four parameters g_{top}, g_{bottom}, g_{left}, g_{right} represent the fraction of times that the subject guesses each location. $g_{top} + g_{bottom} + g_{left} + g_{right} = 1$.

Models in which there is no detection bias ($d_{top} = d_{bottom} = d_{left} = d_{right}$), or models with no guess bias ($g_{top} = g_{bottom} = g_{left} = g_{right} = 1/4$) fail to account for the observed pattern of correct responses and errors.

The full model, including detection bias and guess bias, fits the observed pattern of correct responses and errors well. The full model has 7 free parameters (4 *d*'s, 4 *g*'s, and one constraint), and the data have 12 free parameters (4 x 4 grid of target locations and responses, 4 constraints).

We calculated the **Symmetry Bias Index** for the **raw** fraction correct (f_{top}, f_{bottom}, f_{left}, f_{right}), and also for the **detection** fractions (d_{top}, d_{bottom}, d_{left}, d_{right}) and **guess** fractions (g_{top}, g_{bottom}, g_{left}, g_{right}). Detection fractions and guess fractions were determined by a least-squares best fit to the observed pattern of correct responses and errors.

SUMMARY & CONCLUSIONS

- **Positional biases in symmetry detection interact with the direction of the symmetry axis and evolve over time (100 to 400 ms).**
- **These biases can be induced by the subject's expectation of the orientation of symmetry axis, either implicitly (single-symmetry blocks), or explicitly (cued blocks).**
- **Biases for symmetry detection are present even when cueing follows stimulus presentation. Modeling indicates that this reflects changes in detection, and not merely biased guessing.**
- **These findings indicate that symmetry detection utilizes a dynamic visual routine, in which ongoing processing guides attentional strategy, rather than a static neural computation.**