Choice-dependent perceptual biases

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The perceived motion direction of a dynamic random dot stimulus is systematically biased when preceded by a motion discrimination task (Jazayeri and Movshon, 2007). The biases were originally thought to occur because subjects mistakenly reuse the neural read-out optimized for the discrimination task when forming the percept (Fig.1a, Task-dependent model). In a series of experiments, we demonstrated that this explanation is incorrect and that the biases actually result from the conditioning of the percept on the preceding discrimination judgment (Fig1.b, Choice-dependent model). Experiment 1 was aimed at replicating the biases for an orientation stimulus. Subjects first indicated whether the stimulus orientation was clockwise (CW) or counter-clockwise (CCW) of a randomly chosen reference orientation. Subsequently they had to reproduce the stimulus orientation (Fig1.c). Experiment 2 was identical to Experiment 1 except that the total range of the stimulus were shown at the beginning of each trial. Experiment 3 was identical to Experiment 2 except that subjects were given the correct answer of the discrimination judgment (CW/CCW) and they instead performed an irrelevant decision task. Subjects' estimates were systematically biased away from the decision boundary in Exp. 1(Fig.1 c). Similar biases occurred in Exp. 2 and 3. Because the task-dependent model is insensitive to the stimulus range and is contingent on subjects performing a discrimination, it cannot capture the shift of bias curves in Exp. 2 and in Exp. 3. In contrast, the choice-dependent model predicts all those features in the data assuming that subjects learned the narrower prior range and conditioned their percepts on the given decision outcome.
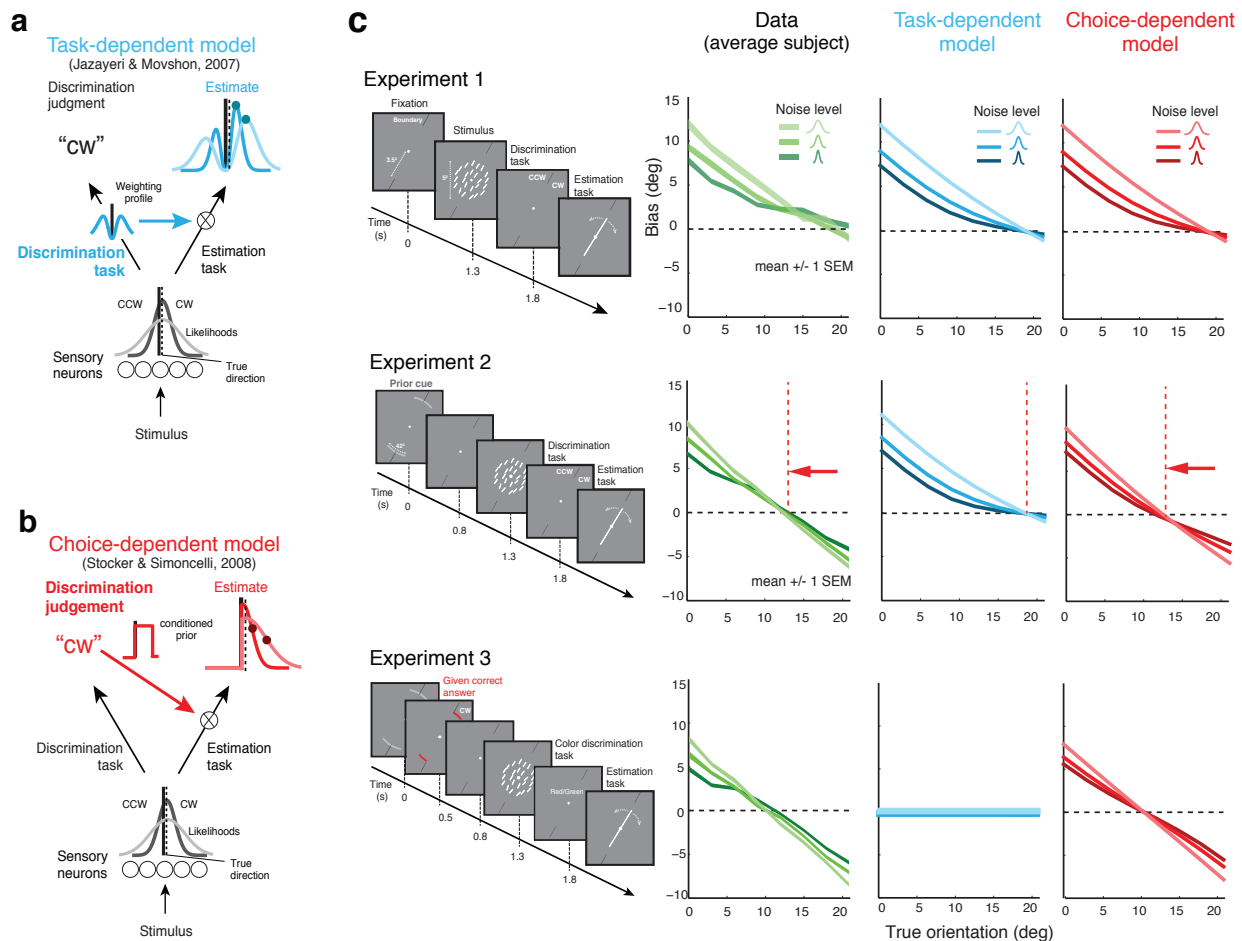

Figure 1: **a**: Task-dependent model: Subjects use the optimal read-out profile from the discrimination task to decode the sensory signal in the estimation task. **b**: Choice-dependent model: Subjects maintain consistency in the inference sequence by conditioning the prior on the preceding decision outcome (CW) and then combine the altered prior with the likelihood to form the percept. **c**: Stimulus consisted of an array of small line segments whose orientations were sampled from a Gaussian centered on a true stimulus orientation. Data (averaged across 5 subjects) and model predictions are shown for the 3 experiments. The task-dependent model fails to capture the bias curves in Exp. 2 and Exp. 3 while the choice-dependent model correctly predicts all data.