Bayesian Analysis of Response Bias in Behavioral Experiments

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Accurate characterizations of behavior during learning experiments are essential for understanding the neural bases of learning. While learning experiments often require subjects to learn multiple tasks simultaneously, most analyze subject performance separately on each individual task, ignoring the true interleaved presentation order of the tasks and making it difficult to distinguish learning behavior from response preferences that may represent biases. We present a Bayesian analysis of a state-space model for characterizing simultaneous learning of multiple tasks and for assessing behavioral biases in these learning experiments. Under the Bayesian analysis the posterior probability densities of the model parameters and the learning state are computed using Monte Carlo Markov Chain methods. Measures of learning, including the learning curve, the ideal observer curve and the learning trial translate directly from our previous likelihood-based state-space model analyses [1].

We compare the Bayesian and previous likelihood-based approaches in the analysis of a simulated conditioned T-maze task and of an actual object-place association task [2]. Modeling the interleaved learning feature of the experiments along with the animal's response sequences allows us to disambiguate actual learning from response biases. The implementation of the Bayesian analysis using the WinBUGS software [3] provides an efficient way to test different models without developing a new algorithm for each model. The new state-space model and the Bayesian estimation procedure suggest an improved, computationally-efficient approach for accurately characterizing learning in behavioral experiments.

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