Causal inference in perception: model selection or averaging?

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We have previously shown that human observers' estimates of spatial location of auditory and visual stimuli are highly consistent with those of a Bayesian observer performing causal inference. In that study, we assumed that observers minimize the mean squared error of their responses, and hence use a decision rule based on the mean of the posterior. This is in effect equivalent to making an estimate which is the weighted average of estimates of two models: a model assuming common cause for the signals, and a model assuming independent causes for the signals. Alternatively, one could argue that a more intuitive strategy would be for the nervous system to rely on (select) the more probable model rather than averaging the estimates of the two models. In this study we investigated whether human perception is more consistent with model selection or model averaging by comparing observations from four data sets with model predictions. In all four data sets, model averaging provided a better fit to the data than model selection. These results suggest that the nervous system tries to minimize the mean squared error of the sensory estimates when faced with multiple sensory signals, leading to a model averaging scheme of processing.