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A canonical model of signal detection theory

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Background

The performance of human subjects engaged in detection and discrimination tasks can often be successfully described within the framework of signal detection theory (SDT) [1]. Fundamental to all signal detection theory models is the conceptual distinction between two processes: discrimination and decision [2]. Discrimination refers to the subject's ability to extract the information available in the stimulus input pertaining to the task at hand. Decision refers to the process determining how this information is to be used in forming an overt response. The discrimination process is assumed to be mainly controlled by the stimuli and to be relatively independent of the task contingencies and the subject's intentions. The decision process is more under volitional control and is affected by task contingencies such as the prior probabilities of the different stimulus types as well as reward asymmetries. In the work presented here, we investigate the ability of attractor-based neuronal network models of decision making to account for the decision process postulated by SDT.

Methods

We study the correspondence between SDT and attractor models of decision making using a reduced one-dimensional canonical model that has been previously introduced [3]. Specifically, we investigate the ability of this reduced model to account for effects accounted for by SDT by a change in the decision criterion. These effects include varying the prior probability of the different stimulus types.

Results

Our analysis demonstrates that attractor models of decision making can account for the systematic change in performance introduced by changing the prior probabilities of the stimulus categories or by changing the pay-off matrix. These effects are modeled as changes in the relative inputs to the decision units. We show that the receiver operating characteristic (ROC) curves generated by the attractor model conform to the ROC curves predicted by standard SDT. Testable predictions with respect to response times will be discussed.

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