Bayesian Models of Dynamic Attentional Selection

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Selection amongst potentially conflicting inputs is a critical facet of many decision making tasks. According to Bayesian optimality principles, the attentional suppression of irrelevant inputs and inappropriate responses should reflect implicitly encoded prior assumptions about the statistical structure of sensory inputs. This argument has particularly interesting ramifications for experimental tasks that violate the statistics of the natural environment. Here, we provide a Bayesian formulation for dynamic attentional selection that elucidates this problem, and consider the consequences for behavioral performance. We illustrate these issues using the Eriksen flanker task, a classical paradigm that explores the effects of competing sensory inputs on response tendencies. In this task, the presence of conflicting flanker stimuli has been shown to interfere with the processing of a central target stimulus, especially on short reaction-time trials. We show how two distinct Bayesian inferential principles can explain the detrimental effects of competition in speeded decisions. The first rests on the notion that the brain may be wired, through either evolutionary adaptation or developmental learning, to encode a compatibility bias: that is, the *prior* belief that spatially proximate items in a visual scene tend to be featurally similar. The second emphasizes the spatial uncertainty induced by overlapping receptive fields of visual sensory processes, which can give rise to a confusion of stimulus identity early on during visual presentation. We also elaborate a simpler, approximate, inference model that formalizes previous work suggesting that different neural structures are involved in the monitoring of conflict and the detection of unexpected events. Finally, we suggest explicit experimental tests to resolve the remaining conflicts between the models.

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