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Title: Optimal experimental design principles explain human attention on a probabilistic categorization task

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The responses of neurons in several visual brain areas, including the frontal eye fields (FEF), supplementary eye fields (SEF), and the lateral intraparietal cortex (LIP), are modulated by attention during a task. Several theoretical models have been offered to explain task-driven attention on categorization tasks. Which is a better explanation of allocation of attention to object features for classification, heuristic strategies or Bayesian optimal experimental design (OED) principles? We optimized the experimental design of a classification task to find environmental statistics in which OED theories of the value of information, and the heuristic strategy of knowing for sure, maximally disagreed about which of two features would be most useful for the classification. A two-category (plankton species A or B), binary-feature scenario was used. In the learning phase of the behavioral experiment, human subjects were presented with simulated plankton specimens, which they classified, receiving immediate feedback. The plankton specimens were chosen at random, and feedback was probabilistic, according to the environmental statistics. Once optimal classification performance was achieved, the information-acquisition phase of the experiment began. In this phase, the features of interest were obscured, and subjects were allowed to select only one of the features to view (via a mouseclick), before classifying the species of the plankton specimen, in each trial. Subjects consistently preferred to view the feature that the OED models judged most useful, rather than the feature that maximized probability of knowing for sure. Additional conditions contrasted the predictions of the various OED models with each other. Results suggest that among the OED models, error minimization (probability gain) explains human search better than information-theoretic principles (KL distance, information maximization, and entropy minimization). Probability gain may help explain task-driven attentional modulation of visual brain areas on categorization tasks.

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