Bayesian model of proactive and reactive control in the AX-CPT

The AX-Continuous Performance Test (AX-CPT) has been used extensively to probe the mechanisms of context processing in schizophrenia (Henderson et al., 2012; Servan-Schreiber, Cohen, & Steingard, 1996). It's been proposed that correct performance on the AX-CPT could be accomplished through two different strategies: a proactive control strategy characterized by anticipatory engagement of task-relevant representations for efficient responding, and a reactive strategy involving the retrieval of task representations at the time of responding only (Braver, 2012). Previous studies have suggested that the context-processing deficits in schizophrenia are associated with an impairment of proactive, but not reactive control (Edwards, Barch, & Braver, 2010).
In this study, we designed two variants of the AX-CPT aiming to bias subjects towards either proactive or reactive control. Each trial in the task consisted of a cue (A or B), followed by a delay period, and a probe (X or Y.) Subjects were asked to press button 1 for AX or BY trials, and button 2 for AY and BX trials. As in previous variants, AX trials were the most frequent, such that A was most often followed by X, increasing the probability of false alarms on AY trials. However, in the absence of proactive preparation, the X probe could trigger the prepotent response to press button 1, making mistakes on BX trials more likely. In the proactive-bias condition, subjects were rewarded for fast and correct responding. In the reactive-bias condition, subjects performed a distractor task during the delay period, preventing them from rehearsing their responses. As expected, subjects made relatively more AY errors in the proactive-bias condition, and more BX errors in the reactive-bias condition. We show that subjects' behavior on the AX-CPT can be modeled as an ideal Bayesian observer that relies on its priors (set by the frequency of the stimuli) in the presence of uncertainty about the cue or probe. As working memory for the cue becomes noisy (in the reactive condition) or as the representation of the probe becomes noisy (due to less time to process the probe in the proactive condition), the agent's priors about the stimuli play a greater role in the decision. We discuss the implications of this model for the different variants of AX-CPT that have been used in the literature.

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