A bayesian model of human sensorimotor control during task switching

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Modern models in Cognitive Neuroscience explain the behavioral and brain responses obtained in task-switching paradigms through a variety of mechanisms whose neurocognitive substrates are not well understood yet. Few studies have attempted to model cognitive control in terms of the probabilistic associations among task events using formal computational tools based on Information theory and Bayesian probability theory. In this study we employed a Bayesian model of surprise (Is) to estimate the amount of information conveyed by sensory, motor and sensorimotor representations in three different task contexts (Switch, NoGo and Oddball), conveying identical visual information but distinct response demands each. The model allowed us to explore trial-by-trial changes in the amount of stimulus-response surprise over the course of the experiment. The behavioral and brain responses measured in each task supported the modeling work and resulted in three distinct information processing profiles, which can be summarized into two major properties. First, there was greater variability in trial-by-trial surprise during the initial 100 trials of each task compared to the remaining trials in the block. Second, contextually informative cues that did not demand any overt response actually conveyed a larger amount of surprise than to-be-responded targets. The modeling of sensorimotor –rather than only sensory or only motor– representations achieved the best fit with the reaction times and other brain indicators of cognitive control. These analyses suggest that task-switching performance could be accounted for through probabilistic sensorimotor associations among stimulus and response representations. Funding: Supported by the Spanish Ministry of Science and Innovation (grant PSI2010-17419/PSIC).