Modeling practice-related reaction time speedup using hierarchical Bayesian methods: Evidence for a process-shift account

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Abstract

In skill-learning tasks, reaction times (RTs) typically decrease with practice. For example, in alphabet arithmetic tasks (e.g. J + 7 = ?), learners respond correctly (e.g. Q) faster on later than on earlier trials. A number of mathematical models have been proposed to account for the functional form of practice-related RT speedup. We aim to evaluate which of two candidates better fits observed speedup data for individual learners across several tasks. In particular, we compare a process-shift account in which learners initially execute an algorithm in constant time, but as trials accumulate, exhibit power-law speedup as they directly retrieve a memorized solution to a delayed exponential model in which RTs decrease exponentially after learners eventually achieve insight into a task-appropriate strategy. Using hierarchical Bayesian models of each account (which can flexibly model learning in individual subjects), we show that the process-shift model better predicts out-of-sample data than the delayed-exponential model.