Bilinguals typically respond faster in task-switching paradigms than monolinguals. Perhaps bilinguals switch more efficiently between task instructions and information. We investigated the computational steps that bilinguals and monolinguals take during a Rapid Instructed Task Learning (RITL) trial, in which subjects quickly shift between task instructions and information. We created computational models of bilinguals and monolinguals using the Adaptive Control of Thought–Rational (ACT–R) architecture. The “monolingual” model performs each step in the task separately. These steps merge into habitual sequences of actions over time. The ”bilingual” model has these compiled sequences by design, and internal control checks have been removed. This reduces execution time and minimizes learning effects. The models correctly reproduce the behavioral pattern observed in earlier studies over a wide parameter space. The results suggest that bilinguals show improved non-linguistic rule-switching are a result of reducing internal control in exchange for faster information routing.