A Cognitive Model of Fraction Arithmetic

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Abstract: Learning about fractions is a critical step on the path to high school mathematics, yet many children never master basic knowledge such as fraction arithmetic procedures. To better understand these difficulties, the present study describes a computational model of fraction arithmetic problem solving. The model demonstrates that the majority of empirically observed errors over all four arithmetic operations can be explained by only two error-generating mechanisms – overgeneralization and repair. Further, by assuming probabilistic selection of solution procedures using associative strengths learned from experience, the model predicts two other empirical phenomena: (1) variation in error rates and relative frequencies of specific errors as a function of problem features, and (2) variable strategy selection within and between problems and individuals. Beyond providing a formal account of errors, the model was used to simulate the effects of variation of instructional parameters, leading to novel predictions regarding potentially effective instructional designs.