

ZMATH 2015c.00527

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Modeling individual differences in response time and accuracy in numeracy.

Cognition 137, 115-136 (2015).

Summary: In the study of numeracy, some hypotheses have been based on response time (RT) as a dependent variable and some on accuracy, and considerable controversy has arisen about the presence or absence of correlations between RT and accuracy, between RT or accuracy and individual differences like IQ and math ability, and between various numeracy tasks. In this article, we show that an integration of the two dependent variables is required, which we accomplish with a theory-based model of decision making. We report data from four tasks: numerosity discrimination, number discrimination, memory for two-digit numbers, and memory for three-digit numbers. Accuracy correlated across tasks, as did RTs. However, the negative correlations that might be expected between RT and accuracy were not obtained; if a subject was accurate, it did not mean that they were fast (and vice versa). When the diffusion decision-making model was applied to the data, we found significant correlations across the tasks between the quality of the numeracy information (drift rate) driving the decision process and between the speed/accuracy criterion settings, suggesting that similar numeracy skills and similar speed-accuracy settings are involved in the four tasks. In the model, accuracy is related to drift rate and RT is related to speed-accuracy criteria, but drift rate and criteria are not related to each other across subjects. This provides a theoretical basis for understanding why negative correlations were not obtained between accuracy and RT. We also manipulated criteria by instructing subjects to maximize either speed or accuracy, but still found correlations between the criteria settings between and within tasks, suggesting that the settings may represent an individual trait that can be modulated but not equated across subjects. Our results demonstrate that a decision-making model may provide a way to reconcile inconsistent and sometimes contradictory results in numeracy research.

Classification: F20 F30 C30

Keywords: diffusion model; response time; accuracy; numeracy; number ability; individual differences
doi:10.1016/j.cognition.2014.12.004