Flexibility of Evidence-Accumulation Models under Practical Constraints

Matt Jones

University of Colorado Boulder

[a] Author note: Matt Jones, Department of Psychology and Neuroscience, University of Colorado Boulder. This research was supported by AFOSR grant FA9550-14-1-0318. Correspondence regarding this article should be addressed to mcj@colorado.edu.

Abstract

Evidence-accumulation models, including the diffusion model (DM) and linear ballistic accumulator (LBA), have been highly influential in modeling speeded decision making. Recent mathematical results prove these models become unfalsifiable when one removes technical assumptions about the distributions governing intertrial variability in growth rates (Jones & Dzhafarov, 2014a). These results also require removal of a particular selective influence assumption (termed SI2), which holds that growth-rate distributions are unaffected by manipulations of preparatory processes such as speed-accuracy tradeoff. The result for the DM also requires that the contribution of diffusion can be arbitrarily small. Although these two allowances are logically and theoretically defensible—SI2 has weak theoretical motivation and has been abandoned in several recent applications to empirical data, and the DM has never specified a lower bound on the contribution of diffusion—it is nonetheless useful to determine how flexible the models are with SI2 retained and with a lower bound on the contribution of diffusion, as well as with qualitative restrictions on the complexity of the growth-rate distributions. The present paper addresses this question by focusing on startpoint variability, a theoretical assumption that has been held as essential to fitting data. It reports three results demonstrating that growth-rate variability is flexible enough to mimic the effects of startpoint variability, even under the constraints of SI2, a lower bound on diffusion, and unimodal growth-rate distributions. First, analytical derivations show that the standard LBA is formally equivalent to a generalized LBA with no startpoint variability, using unimodal growth-rate distributions that adhere to SI2. Second, the same is shown to hold for the DM in the limit of negligible diffusion. Third, simulations with real data that this mimicry problem arises even with large levels of diffusion: The standard DM can be closely mimicked by a generalized DM with no startpoint variability, unimodal growth-rate distributions obeying SI2, and diffusion as strong as in the original model. In conclusion, these three restrictions still leave the models excessively flexible, in that the theoretical question of startpoint variability remains unidentifiable.

Keywords: Choice response time; evidence-accumulation models; diffusion model; model complexity; model mimicry