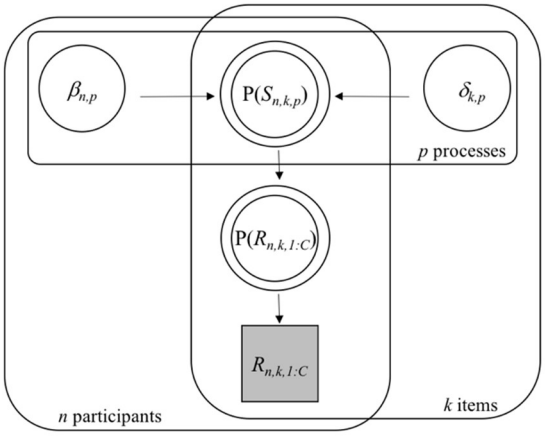
Supplemental Material S1. Directed acyclic graphs of the variables, dependencies, and prior assumptions for the cross-sectional and longitudinal Bayesian MPT models.

A) Directed acyclic graph depicting variables and dependencies in the cross-sectional MPT model, used to estimate the item difficulty values from an independent data set. B) Directed acyclic graph depicting variables and dependencies in the longitudinal MPT model. The variables β, Δ, δ, and P(S) are defined as before, except now they apply to the probability of success at each latent decision node of the MPT model. The default parameters for the prior distributions on naming abilities β are intended to be minimally informative about the probability of a correct response on an item of average difficulty (MPT-P(S)). The outcome of a naming trial R is modeled as a draw from a categorical distribution parametrized by the probabilities of each response type P(R), which are determined by the latent probabilities of success in the MPT model equations. The MPT-P(S) and MPT-E(D) summary statistics are estimated for each testing session with each participant. The change in MPT-P(S) or MPT-E(D) between two testing sessions is estimated by subtracting the posterior samples of the summary statistic for session two from the corresponding samples in the sampling chain for session one, and examining the resulting chain. circle/square = continuous/discrete variable, shaded/unshaded = observed/unobserved variable, single/double border = stochastic/deterministic variable, arrow = dependency, rounded square = set. The ~ symbol means "is distributed as."

A)



$\beta_{n,p} \sim \text{Gaussian}(0, 1)$

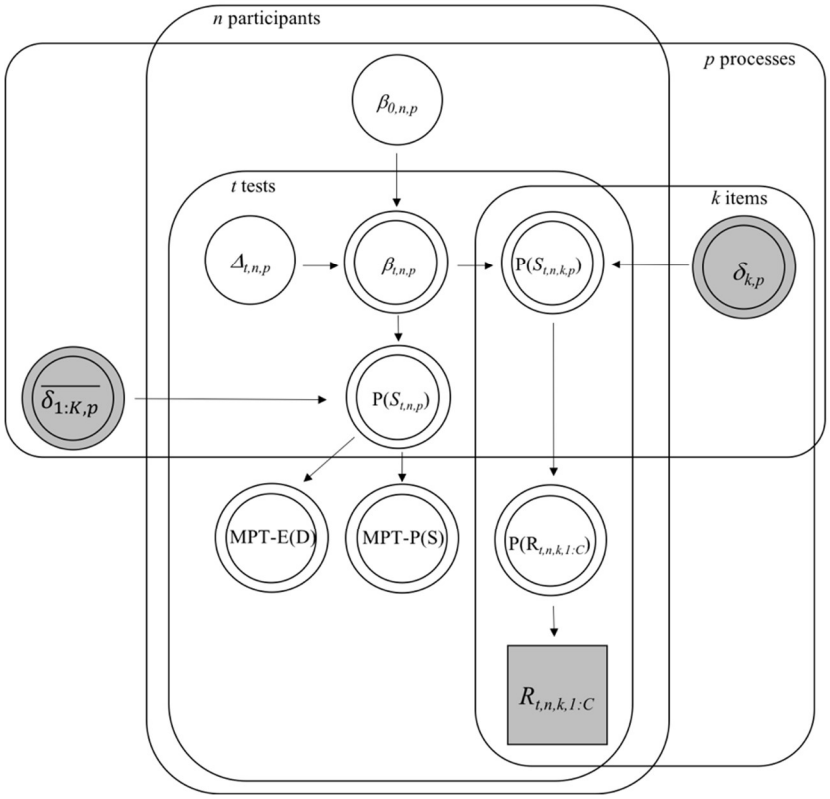
$\delta_{k,p} \sim \text{Gaussian}(0, 1)$

$$\text{P}(S_{n,k,p}) = \frac{e^{\beta n,p - \delta k,p}}{1 + e^{\beta n,p - \delta k,p}}$$

$\text{P}(R_{n,k,1:C}) = \text{MPT}(\text{P}(S_{n,k,1:P}))$

$R_{n,k,1:C} \sim \text{Categorical}(\text{P}(R_{n,k,1:C}))$

B)



$$\beta_{0,n,p} \sim \text{Gaussian}(2.5, 2.8)$$

$$\Delta_{1,n,p} = 0$$

$$\Delta_{t>1,n,p} \sim \text{Gaussian}(0, 1)$$

$$\beta_{t,n,p} = \beta_{0,n,p} + \sum_{tt=1}^{t} (\Delta_{tt,n,p})$$

$$P(S_{t,n,k,p}) = \frac{e^{\beta_{t,n,p} - \delta_{k,p}}}{1 + e^{\beta_{t,n,p} - \delta_{k,p}}}$$

$$P(R_{t,n,k,1:C}) = \text{MPT}(P(S_{t,n,k,1:P}))$$

$$R_{t,n,k,1:C} \sim \text{Categorical}(P(R_{t,n,k,1:C}))$$

$$\overline{\delta_{1:K,p}} = \frac{\sum_{k=1}^{K} (\delta_{k,p})}{K}$$

$$P(S_{t,n,p}) = \frac{e^{\beta_{t,n,p} - \overline{\delta_{1:K,p}}}}{1 + e^{\beta_{t,n,p} - \overline{\delta_{1:K,p}}}}$$

$$\text{MPT-P(S)} = \prod_{p=1}^{P} (P(S_{t,n,p}))$$

$$\text{MPT-E(D)} = \frac{\sum_{p=1}^{P} (p P(\sum_{p=1}^{P} (S_{t,n,p}) = p))}{P}$$