The simplest form of a standard 3-stage hierarchical Bayesian model in the context of modeling MEP size can be described as follows. Let there be N_P exchangeable sequences $\left\{ ({x_i}^p, {y_i}^p)_{i=1}^{n(p)} \mid j = 1, 2 \dots N_P \right\}$ of MEP sizes ${y_i}^p \in \mathbb{R}^+$ recorded at stimulation intensity ${x_i}^p \in \mathbb{R}_0^+$ from p^{th} participant, for a total of N_P participants. Here $n(p)$ denotes the number of intensities tested for p^{th} participant.

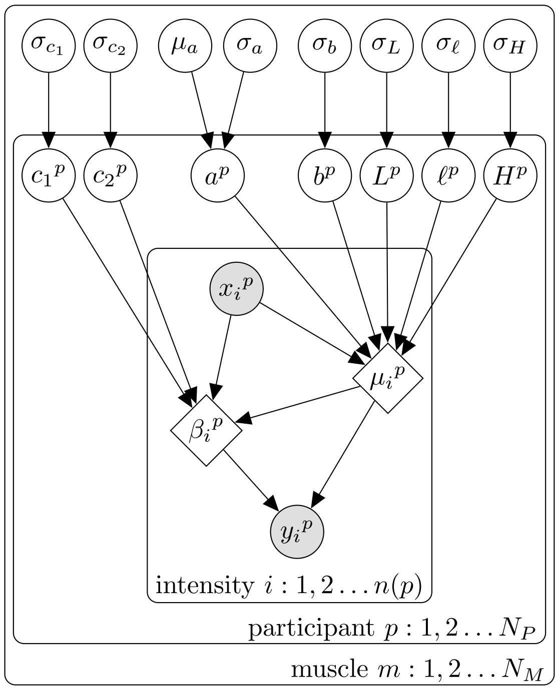
The first stage of hierarchy is the *participant-level* and specifies parametric model $P\left({y_i}^p \mid {x_i}^p, \theta^p\right)$ for each of the N_P participants and models the MEP size ${y_i}^p$ as a function of stimulus intensity ${x_i}^p$ and participant-specific parameters θ^p. In the second stage, $\theta_1, \theta_2 \dots \theta^P$ are assumed to be exchangeable and generated from a common distribution $P\left(\theta^p \mid \gamma\right)$ with hyper-parameters γ. In the third stage, the hyper-parameters γ are assumed to be unknown and assigned *weakly-informative* prior, also called hyperprior-density $P\left(\gamma\right)$.

$$ {y_i}^p \mid {x_i}^p, \theta^p, \gamma \sim P\left({y_i}^p \mid {x_i}^p, \theta^p, \gamma\right) \tag{4.3.1} $$

$$ \theta^p \mid \gamma \sim P\left(\theta^p \mid \gamma\right) \tag{4.3.2} $$

$$ \gamma \sim P\left(\gamma\right) \tag{4.3.3} $$

Figure 4.3.1 shows the graphical representation of the default hierarchical model implemented by hbmep for fitting recruitment-curves on TMS data [ref.] in [ref. to function comparison fig.].



Observation model

$y_i{}^p \sim \text{Gamma}\left(\mu_i{}^p \cdot \beta_i{}^p, \beta_i{}^p\right)$

$\mu_i{}^p \leftarrow \mathcal{F}\left(x_i{}^p \mid a^p, \Omega^p\right)$

$\beta_i{}^p \leftarrow \dfrac{1}{c_1{}^p} + \dfrac{1}{c_2{}^p \cdot \mu_i{}^p}$

Participant specific parameters

$a^p \sim \text{TruncatedNormal}\left(\mu_a, \sigma_a\right)$

$\theta^p \sim \text{HalfNormal}\left(\sigma_\theta\right) \forall \theta^p \in \Omega^p$

Priors

$\mu_a \sim \text{TruncatedNormal}\left(50, 20\right)$

$\sigma_a \sim \text{HalfNormal}\left(30\right)$

$\sigma_L \sim \text{HalfNormal}\left(0.05\right)$

$\sigma_\theta \sim \text{HalfNormal}\left(5\right) \forall \sigma_\theta \in \Omega$

$\Omega^p \leftarrow \{b^p, L^p, \ell^p, H^p, c_1{}^p, c_2{}^p\}$

$\Omega \leftarrow \{\sigma_b, \sigma_\ell, \sigma_H, \sigma_{c_1}, \sigma_{c_2}\}$