$$
\begin{aligned}
\big[\alpha_\psi, \beta_\psi, \gamma_\psi, \alpha_r, \beta_r, \gamma_r, & p_2, \boldsymbol{p_3}, \boldsymbol{z1}, \boldsymbol{z2} \mid \boldsymbol{x}\big] \propto \\
& \prod_{s=1}^{181} \prod_{y \in Y} \prod_{v=1}^{V_{s,y}} \text{categorical}\big(x_{s,y,v} \mid \boldsymbol{\pi} \cdot \boldsymbol{z_{s,y}}\big) \\
& \times \prod_{s=1}^{181} \prod_{y=2}^{21} \text{Bernoulli}\big(z1_{s,y} \mid f(\alpha_\psi, \beta_\psi, \gamma_\psi, z1_{s,y-1})\big) \\
& \times \text{Bernoulli}\big(z2_{s,y} \mid g(\alpha_r, \beta_r, \gamma_r, z2_{s,y-1})\big) \\
& \times \prod_{s=1}^{181} \text{Bernoulli}\big(z1_{s,1} \mid h(\alpha_\psi, \beta_\psi)\big) \text{Bernoulli}\big(z2_{s,1} \mid m(\alpha_r, \beta_r)\big) \\
& \times \text{normal}\big(\alpha_\psi \mid 0, 2.59\big) \text{normal}\big(\beta_\psi \mid 0, 2.59\big) \text{normal}\big(\gamma_\psi \mid 0, 2.59\big) \\
& \times \text{normal}\big(\alpha_r \mid 0, 2.59\big) \text{normal}\big(\beta_r \mid 0, 2.59\big) \text{normal}\big(\gamma_r \mid 0, 2.59\big) \\
& \times \text{uniform}\big(p_2 \mid 0, 1\big) \text{Dirichlet}\big(\boldsymbol{p_3} \mid 1, 1, 1\big)
\end{aligned}
$$