Extended Mackintosh model equations:

$$\Delta V_S^{n+1} = \alpha_S^n \beta^+ \cdot (1 - \partial V_S^n) \cdot |R^n| \tag{1}$$

$$\overline{\Delta V_S^{n+1}} = \alpha_S^n \beta^- \cdot (1 + \partial V_S^n) \cdot |R^n| \tag{2}$$

$$\partial V_S^n = V_S^n - \overline{V_S^n} \tag{3}$$

$$\alpha_S^{n+1} = \alpha_S^n + \Delta\alpha_S^{n+1} \text{ when } R_S^n > 0 \tag{4}$$

$$\alpha_S^{n+1} = \alpha_S^n + \overline{\Delta\alpha_S^{n+1}} \text{ when } R_S^n < 0 \tag{5}$$

$$\Delta\alpha_S^{n+1} = -\theta^+ \cdot \left(\Lambda^+ - \Lambda^-\right) \tag{6}$$

$$\overline{\Delta\alpha_S^{n+1}} = -\theta^- \cdot \left(\mathcal{R}^+ - \mathcal{R}^-\right) \tag{7}$$

$$\Lambda^+ = \left|\lambda^n - V_S^n + \overline{V_S^n}\right| \tag{8}$$

$$\Lambda^- = \left|\lambda^n - \sum_{i \neq A} \left(V_i^n + \overline{V_i^n}\right)\right| \tag{9}$$

$$\mathcal{R}^+ = \left||R^n| + V_S^n - \overline{V_S^n}\right| \tag{10}$$

$$\mathcal{R}^- = \left||R^n| + \sum_{i \neq A} \left(V_i^n - \overline{V_i^n}\right)\right| \tag{11}$$

$$\tag{12}$$

α_i^n = associability of the CS i on trial n.

β = Learning rate parameter for the US, where β^+ (excitatory) ¿ β^- (inhibitory)

λ_i^n = intensity of the US with stimuli i at trial n.

$V_{i,j}^{n+1}$ = associative strength of the CS i on trial $n+1$.

$\overline{V_{i,j}^{n+1}}$ = inhibitory associative strength of the CS i on trial $n+1$.

θ = learning-rate parameters for changes in α on excitatory and inhibitory trials. θ^E (excitatory) ¿ θ^I (inhibitory)

R = Reinforcing value (excitatory/inhibitory)