RESCORLA AND WAGNER (1972)

$$\Delta V_A^n = \alpha_A \cdot \beta \cdot (\lambda - V_\Sigma^{n-1})$$

MACKINTOSH (1975)

$\Delta\alpha_A$ is positive if $|\lambda - V_A| < |\lambda - V_X|$

$\Delta\alpha_A$ is negative if $|\lambda - V_A| \geq |\lambda - V_X|$

$$\Delta V_A = \alpha_A \cdot (\lambda - V_\Sigma)$$

PEARCE AND HALL (1980)

Associability change

$$\alpha_A = \left|\lambda^{+(n-1)} - (V_\Sigma^{+(n-1)} - V_\Sigma^{-(n-1)})\right|$$

Excitatory learning

$$\Delta V_A^+ = S_A \cdot \alpha_A \cdot \lambda^+$$

Inhibitory learning

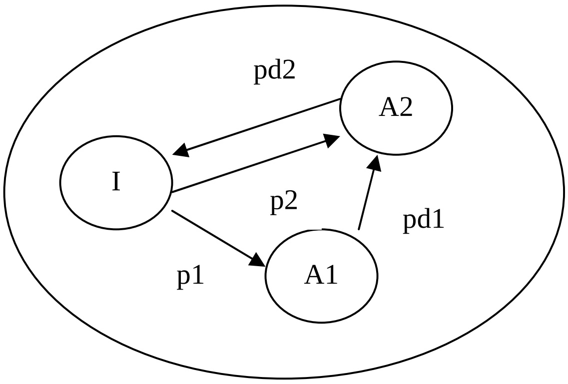
$$\Delta V_A^- = S_A \cdot \alpha_A \cdot \lambda^-$$

$$\lambda^- = \left(V_\Sigma^+ - V_\Sigma^-\right) - \lambda^+$$

Conditioned response

$$CR = V_\Sigma^+ - V_\Sigma^-$$

SOP - WAGNER (1981)



Decay functions

$$p_{A1_t} = p_{A1_0}(1 - p_{d1})^t$$

$$p_{A2_t} = p_{A2_0}(1 - p_{d2})^t + \sum_{i=1}^{t}\left[p_{A1_0}(1 - p_{d1})^{i-1} p_{d1}(1 - p_{d2})^{t-i}\right]$$

$$p_{A2_t} = p_{A2_0}(1 - p_{d2})^t + p_{A1_0} p_{d1}(1 - p_{d2})^{t-1}\left[\frac{1 - \left(\frac{1 - p_{d1}}{1 - p_{d2}}\right)^t}{1 - \left(\frac{1 - p_{d1}}{1 - p_{d2}}\right)}\right]$$

Where $p_{d1} > p_{d2}$ (in simulations, $p_{d1} = 5 \cdot p_{d2}$)

Learning rules

Excitatory

$$\Delta V^{+}_{CS-US} = L^{+}\sum^{t}(p_{A1,CS} \cdot p_{A1,US})$$

Inhibitory

$$\Delta V^{-}_{CS-US} = L^{-}\sum^{t}(p_{A1,CS} \cdot p_{A2,US})$$

Net

$$\Delta V_{CS-US} = \Delta V^{+}_{CS-US} - \Delta V^{-}_{CS-US}$$

Note: $L^{+} > L^{-}$

Retrieval rule

$$p_{2,US|\sum CS} = \sum V_{CS_i-US}(r_1 p_{A1,CS_i} + r_2 p_{A2,CS_i})$$

Note: $0 \le p_2 \le 1$

Note: r1 > r2 (In simulations, r1 = 1, and r2 = 0.01)

Distractor rule

$$p'_{d1} = p_{d1} + \frac{\Delta p_{A1,X}}{C1}$$

$$p'_{d2} = p_{d2} + \frac{\Delta p_{A2,X}}{C2}$$

Note: C2 > C1 (In simulations, C1 = 2, and C2 = 10)

Response-generation rule

$$R_j = f_j(w_{1,j}\, p_{A1,US} + w_{2,j}\, p_{A2,US})$$

Note: w_1 is always positive, w_2 can be either positive or negative ($w_1 > w_2$)

PEARCE (1987)

Generalization

Excitation

$$e_{A'} = {}_{A}S_{A'} \cdot E_{A} \qquad e_{A} = \sum_{j=1}^{n} {}_{j}S_{A} \cdot E_{j}$$

$${}_{A}S_{A'} = \frac{P_{com}}{P_{\Sigma A}} \cdot \frac{P_{com}}{P_{\Sigma A'}}$$

Inhibition

$$i_{A} = {}_{A}S_{A'} \cdot I_{A} \qquad i_{A} = \sum_{j=1}^{n} {}_{j}S_{A} \cdot I_{j}$$

$${}_{A}S_{A'} = \frac{P_{com}}{P_{\Sigma A}} \cdot \frac{P_{com}}{P_{\Sigma A'}}$$

Learning

Excitatory

$$\Delta E_{A} = \beta \cdot (\lambda - \bar{\bar{E}}_{A})$$

$$\bar{\bar{E}}_{A} = E_{A} + e_{A}$$

Inhibitory

$$\Delta I_{A} = \beta \cdot (\lambda - \bar{\bar{I}}_{A})$$

$$\bar{\bar{I}}_{A} = I_{A} + i_{A}$$

Net associative strength

$$\bar{\bar{V}}_{A} = E_{A} + e_{A} - (I_{A} + i_{A}) \qquad \Delta E_{A} = \beta \cdot (\lambda - \bar{\bar{V}}_{A})$$

PEARCE (1994)

Pattern learning

$$a_j = \sum w_{i,j} \cdot o_i$$

$$\sum o_i^2 = 1 \qquad o_i = \frac{1}{\sqrt{n}} \qquad o_k = \frac{P_k}{\sqrt{\sum P_i^2}}$$

$$a_X = n_c\left(\frac{1}{\sqrt{n_X}} \cdot \frac{1}{\sqrt{n_Y}}\right)$$

Learning

$$\Delta E = \alpha \cdot \beta \cdot (\lambda - E)$$

$$V_A = E_A + \sum S_{A,i} \cdot E_i$$

$$\Delta E_A = \alpha \cdot \beta \cdot (\lambda - V_A)$$

VAN HAMME AND WASSERMAN (1994)

Modification of Rescorla and Wagner's (1972) model

Cue	**Outcome**	**Resulting parameters in equation**
Present	Present	$\Delta V_A^n = \alpha_1 \cdot \beta_1 \cdot (\lambda - V_\Sigma^{n-1})$
Present	Absent	$\Delta V_A^n = \alpha_1 \cdot \beta_2 \cdot (0 - V_\Sigma^{n-1})$
Absent	Present	$\Delta V_A^n = \alpha_2 \cdot \beta_1 \cdot (\lambda - V_\Sigma^{n-1})$
Absent	Absent	$\Delta V_A^n = \alpha_2 \cdot \beta_2 \cdot (0 - V_\Sigma^{n-1})$

α_1 = learning rate parameter for cue i present (positive value)

α_2 = learning rate parameter for cue i absent (negative value)

β_1 = learning rate parameter for outcome (positive value)

β_2 = learning rate parameter for outcome (positive value lower than β_1)

DICKINSON AND BURKE (1996)

Modification of Wagner's (1981) SOP model

Learning rules

Excitatory

$$\Delta V^{+}_{CS-US} = L^{+}\sum^{t}(p_{A1,CS} \cdot p_{A1,US}) + L^{+}\sum^{t}(p_{A2,CS} \cdot p_{A2,US})$$

Inhibitory

$$\Delta V^{-}_{CS-US} = L^{-}\sum^{t}(p_{A1,CS} \cdot p_{A2,US}) + L^{-}\sum^{t}(p_{A2,CS} \cdot p_{A1,US})$$

Net

$$\Delta V_{CS-US} = \Delta V^{+}_{CS-US} - \Delta V^{-}_{CS-US}$$

Note: $L^{+} > L^{-}$