The Rescorla-Wagner Model of Classical Conditioning

Elements of the Rescorla-Wagner Model

- Variables
  - V Associative value of a stimulus
  - DeltaV Change in associative value

- Parameters
  - Alpha Salience of a stimulus
  - Beta Learning rate (depends on US)
  - Lamda Maximum value of a stimulus

Rescorla-Wagner Model Applied to Conditioning with a Simple CS

- Initial values:
  - V = 0 (no associative strength)
  - Alpha = 0.5 (intermediate level of CS salience)
  - Beta = 0.5 (US at intermediate strength)
  - Lamda = 100% (limit of associative strength)

- Change in value following each trial:
  - DeltaV = Alpha*Beta*(Lamda – V)
  - V = V + DeltaV
Example Computations: Conditioning a Simple CS

- **Trial 1**
  - $\delta V = 0.5 \times 0.5(100 - 0) = 0.25 \times 100 = 25.00$
  - $V = 0.0 + 25.00 = 25.00$

- **Trial 2**
  - $\delta V = 0.5 \times 0.5(100 - 25.00) = 0.25 \times 75.00 = 18.75$
  - $V = 25.00 + 18.75 = 43.75$

- **Trial 3**
  - $\delta V = 0.5 \times 0.5(100 - 43.75) = 0.25 \times 56.25 = 14.06$
  - $V = 43.75 + 14.06 = 57.81$

Graph Showing Progress of CS Conditioning as a Function of Trials

Rescorla-Wagner Model Applied to Extinction with a Simple CS

- **Initial values:**
  - $V = 100\%$ (assume fully conditioned CS)
  - $\lambda = 0$ (minimum level of conditioning)
  - $\alpha = 0.5$ (intermediate salience of CS)
  - $\beta = 0.5$ (intermediate strength of US)

- **Change in value following each trial**
  - $\delta V = 0.5 \times 0.5 \times (0 - V)$
  - $V = V + \delta V$
Graph Showing Progress of CS Extinction as a Function of Trials

Compound Conditioning Model

- Two elements, A (tone) and B (light)
  - $V_A =$ Associative value of the tone
  - $V_B =$ Associative value of the light
  - $V_{AB} =$ Associative value of the compound
- Changes in value following each trial
  - $\Delta V_A = \alpha_A \times \beta \times (\lambda - V_{AB})$
  - $\Delta V_B = \alpha_B \times \beta \times (\lambda - V_{AB})$
  - $V_A = V_A + \Delta V_A$
  - $V_B = V_B + \Delta V_B$
  - $V_{AB} = V_A + V_B$

Compound Conditioning

Overshadowing: Initial Values

- $V_A = V_B = 0$ (both elements neutral stimuli)
- $\alpha_A = 0.60$ (salience of tone)
- $\alpha_B = 0.40$ (salience of light)
- $\beta = 0.50$ (intermediate US strength)
- $\lambda = 100\%$ (maximum value possible)
Overshadowing Example

- Trial 1
  - $V_{AB} = 0.00 + 0.00 = 0.00$
  - Delta $V_A = 0.60\times 0.50 (100 - 0.00) = 30.00$
  - Delta $V_B = 0.40\times 0.50 (100 - 0.00) = 25.00$
  - $V_A = 0.00 + 30.00 = 30.00$
  - $V_B = 0.00 + 25.00 = 25.00$
  - $V_{AB} = 30.00 + 25.00 = 55.00$

Graph Showing Values of Elements and Compound CS as Functions of Trials

Compound Conditioning: Blocking

- One element begins fully conditioned, the other as a neutral stimulus:
  - $V_A = 100$ (tone fully conditioned)
  - $V_B = 0$ (light still neutral)
- Assume that both are equally salient:
  - $\alpha_A = \alpha_B = 0.50$
- Other parameters:
  - $\beta = 0.50$
  - $\lambda = 100$
**Blocking Example**

- Trial 1
  - $V_{AB} = V_A + V_B = 100 + 0 = 100$
  - $\Delta V_A = 0.50 \times 0.50(100 - 100) = 0.25 \times 0.0 = 0$
  - $\Delta V_B = 0.50 \times 0.50(100 - 100) = 0.25 \times 0.0 = 0$
  - $V_A = 100 + 0 = 100$
  - $V_B = 0 + 0 = 0$

- Thus, the tone remains fully conditioned and the light remains a neutral stimulus. The tone has blocked conditioning to the light!

- This continues without change over all succeeding trials.

**Graph Showing Blocking of Conditioning to Light Across Trials**

**Compound Conditioning: Overexpectation**

- Both elements begin fully conditioned:
  - $V_A = V_B = 100$

- Trial 1
  - $V_{AB} = 100 + 100 = 200$  (!)
  - $\Delta V_A = 0.50 \times 0.50(100 - 200) = 0.25 \times (-100) = -25$
  - $\Delta V_B = 0.50 \times 0.50(100 - 200) = 0.25 \times (-100) = -25$
  - $V_A = 100 + (-25) = 75$
  - $V_B = 100 + (-25) = 75$
  - $V_{AB} = 75 + 75 = 150$  (a loss of value!)
Graph Showing Overexpectation Effect Across Trials

- Note Declining V with Reinforcement!!

Lamda = 100
Overexpectation = 200 initially

V_a
V_b
V_{ab}

Trial
0 1 2 3 4 5 6 7 8 9 10

Compound Conditioning: Conditioned Inhibition

- One element of the compound CS is presented as a simple CS, paired with the US.
- On other trials, the compound CS is presented, but always in extinction.
- Our model therefore will have to consider what happens during each kind of trial.

Conditioned Inhibition Model

- Simple CS trials:
  - \( \Delta V_A = \alpha_A * \beta * (100 - V_A) \) (reinforce)
- Compound CS trials:
  - \( \Delta V_A = \alpha_A * \beta * (0 - V_{ab}) \) (extinguish)
  - \( \Delta V_B = \alpha_B * \beta * (0 - V_{ab}) \)
- Initial Conditions
  - \( V_A = V_B = V_{ab} = 0 \)
  - \( \alpha_A = \alpha_B = 0.50 \)
  - \( \beta = 0.50 \)
Conditioned Inhibition Example

- **Trial 1 – Tone alone**
  - \( \Delta A = 0.50 \times 0.50(100 - 0) = 0.25 \times 100 = 25.00 \)
  - \( V_A = 0.00 + 25.00 = 25.00 \)
  - \( V_{AB} = 25.00 + 0.00 = 25.00 \)
- **Trial 1 – Tone plus light**
  - \( \Delta A = 0.50 \times 0.50(0 - 25.00) = 0.25(-25) = -6.25 \)
  - \( \Delta B = 0.50 \times 0.50(0 - 25.00) = 0.25(-25) = -6.25 \)
  - \( V_A = 25.00 - 6.25 = 18.75 \)
  - \( V_B = 0.00 - 6.25 = -6.25 \) (inhibitory!!)
  - \( V_{AB} = 18.75 + -6.25 = 12.50 \)

Graph Showing Inhibitory Conditioning of One Element of a Compound

Contextual Conditioning

- Contextual stimuli – background stimuli present during conditioning
- Rescorla and Wagner suggested that contextual stimuli participate in the conditioning process.
- Thus, even “simple” conditioning with a single CS is an example of compound conditioning.
- Conditioning of contextual cues has proven important for understanding certain effects.
Deficiencies of the Rescorla-Wagner Model

- Despite its strong successes, the Rescorla-Wagner model does have its deficiencies:
  - It has failed some crucial tests, which show that more is going on during classical conditioning than associating stimuli with the US.
  - The model completely lacks a mechanism for handling those all-important temporal parameters. Thus it does not explain, for example, why certain CS-US intervals work better than others.
- Even so, it is important because it demonstrated that quantitative predictions are possible in this area.