PSYC 5303 – Lecture 4

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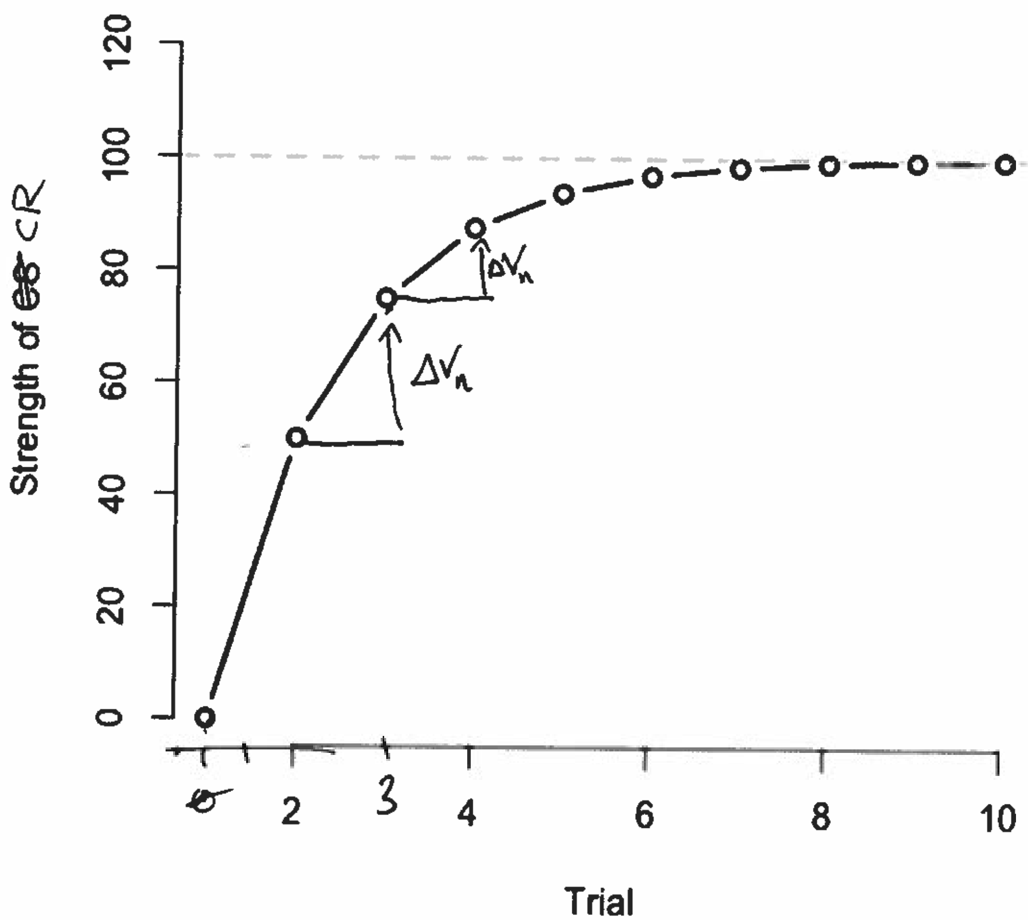
Mathematical model of conditioning

We know that conditioning looks like this:



Goal – construct a mathematical equation to produce this curve.

Rescorla-Wagner Model

- uses a "difference equation"
- V_n represents associative strength of CS at trial n
- Equation:

$\Delta V = \alpha\beta(\lambda - \Sigma V)$

$$V_n = V_{n-1} + \Delta V_n$$

$$\text{where } \Delta V_n = \underline{c(V_{\text{max}} - V_{\text{tot}})}$$

- Parameters:
  - c = "learning rate" (depends on salience of CS, strength of US, etc.)
  - V_{max} = maximum possible associative strength
  - V_{tot} = total associative strength of *all* CS

- today, we'll use this equation to generate some standard phenomena in classical conditioning
  - acquisition
  - extinction
  - blocking

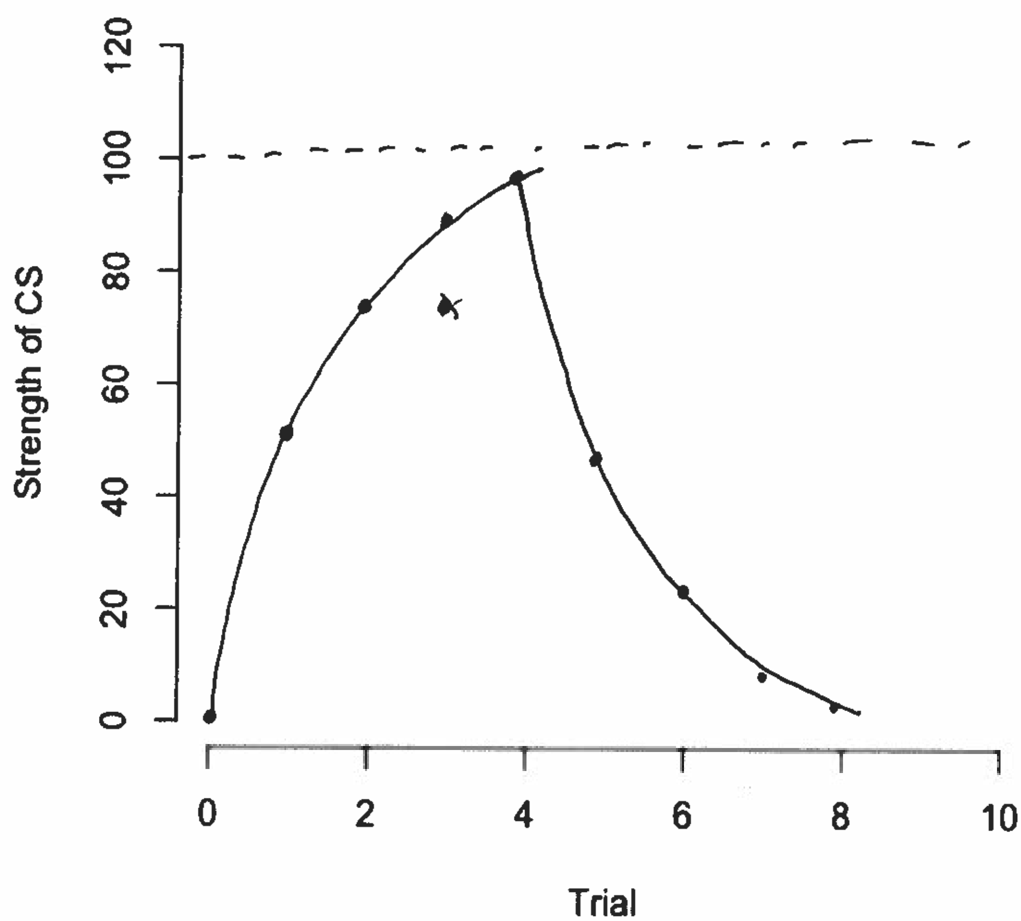
Acquisition

Set $c = 0.5$ and $V_{\text{max}} = 100$

Trial (n)	Associative strength $V_n = V_{n-1} + c(V_{\text{max}} - V_{\text{tot}})$
1	$V_1 = V_0 + c\left(V_{max} - V_{tot}\right)$ $= 0 + 0.5\left(100 - 0\right)$ $= 0 + 50 = 50$
2	$V_2 = V_1 + 0.5\left(100 - 50\right)$ $= 50 + 0.5\left(50\right) = 50 + 25 = 75$
3	$V_3 = V_2 + 0.5\left(100 - 75\right)$ $= 75 + 0.5\left(25\right) = 87.5$
4	$V_4 = V_3 + 0.5\left(100 - 87.5\right)$ $= 87.5 + 0.5\left(12.5\right) = 93.75$

Acquisition

Let's plot our numbers here:



Extinction

Keep $c = 0.5$ but now $V_{\text{max}} = 0$ "asymptote"

Trial (n)	Associative strength $V_n = V_{n-1} + c(V_{\text{max}} - V_{\text{tot}})$
5	$V_5 = V_4 + c(V_{max} - V_{tot})$ $= 93.75 + 0.5(0 - 93.75)$ $= 46.88$
6	$V_6 = V_5 + 0.5(0 - 46.88)$ $= 46.88 + 0.5(0 - 46.88) =$ $= 23.44$
7	$V_7 = 23.44 + 0.5(0 - 23.44)$ $= 11.72$
8	$V_8 = 11.72 + 0.5(0 - 11.72)$ $= 5.86$

Blocking

Recall from lecture 2 – **blocking** happens when presence of an established CS interferes with conditioning a *new* CS

Training phase 1:

- CS_a (noise) + US (shock) $\rightarrow$ UR (fear response)
- (repeat)
- CS_a (noise) $\rightarrow$ CR (fear response) V_{max} is attained!

Training phase 2:

- CS_a (noise) + CS_b (light) + US (shock) $\rightarrow$ UR (fear response)
- (repeat)
- CS_a (noise) + CS_b (light) $\rightarrow$ CR (fear response)

Test phase:

- CS_b (light) $\rightarrow$ no CR!

Interpretation: previous learning <u>blocks</u> learning of CS_b

Blocking

Let's see how Rescorla-Wagner would predict this:

Phase 1:

- CS_a (noise) + US (shock) $\rightarrow$ UR (fear response)
- (repeat)
- CS_a (noise) $\rightarrow$ CR (fear response)

After Phase 1, we can assume the following:

- $V_{\text{noise}} = V_{\text{max}} = 100$
- $V_{\text{light}} = 0$

Thus, at the beginning of Phase 2, we have

- $V_{\text{tot}} = V_{\text{noise}} + V_{\text{light}} = 100 + 0 = 100$

Blocking

Now, at the beginning of Phase 2, here's what happens:

$$\begin{aligned} V_n &= V_{n-1} + c(V_{\text{max}} - V_{\text{tot}}) \\ &= V_{n-1} + c(100 - 100) \\ &= V_{n-1} + 0 \end{aligned}$$

That is, there is no learning that occurs! (i.e., $\Delta V_n = 0$)