

## RESCORLA-WAGNER MODEL

### I. HISTORY

- A. Ever since Pavlov, it was assumed that any CS followed contiguously by any US would result in conditioning.
- B. Not true: Contingency
- C. Not true: Taste Aversion Learning
- D. Not true: Blocking

### II. FOUNDATION

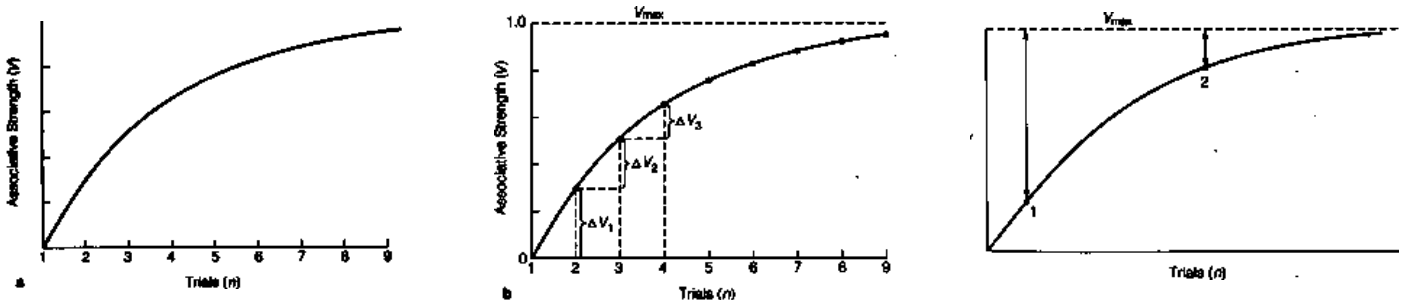
- A. The foundation for the model was Kamin's work on blocking.
- B. Kamin explained blocking by saying that for conditioning to occur, the US must be unexpected or surprising.
- C. If a US was surprising, the organism will search their memory for possible causes.
- D. If a US was expected, then an adequate predictor must be already available; no memory search occurs and no new learning takes place.
- E. "Expectations" are the key.

### III. THE MODEL

- A. Rescorla-Wagner Model extended Kamin's notion of expectancy.
- B. The precise amount of conditioning is dependent upon the amount of surprise.
- C. Surprise not only determines whether conditioning occurs but also how strong it is.
- D. Model variables.
  1. Strength of association =  $V$
  2. Change in associative strength on each trial =  $\Delta V$
  3. Asymptote =  $V_{max}$
  4. Strength of conditioning at the beginning of any trial "n" =  $V_n$
  5. Surprise =  $(V_{max} - V_n)$
  6. The change in the strength of the association produced by trial "n" =  $\Delta V_n$
  7. Constant representing the speed of conditioning =  $c$

$$\Delta V_n = c(V_{max} - V_n)$$

$$\Delta V_n = c(V_{\max} - V_n)$$



E. The learning curve.

1. On the first trial V will increase by a large amount.
2. On successive trials, the increase in V on each trial will get progressively smaller until V approaches a stable value or asymptote.
3. At the beginning of conditioning,  $V_n$  will be much less than  $V_{\max}$ , the subject will not expect the US and will be surprised; therefore conditioning will be strong.
4. As conditioning proceeds, the difference between  $V_n$  and  $V_{\max}$  will decrease and the US will be less surprising therefore conditioning will be weak.
5. Learning curves are similar -- learning increases over trials but at a declining rate until asymptote is reached.
6. But learning curves do differ -- actual asymptote and the rate at which asymptote is reached differs across experiments dependent upon the choice of CS and US.
7. Model takes actual maximal asymptote into consideration with  $V_{\max}$
8. Model takes actual speed at which asymptote is reached into consideration with "c"

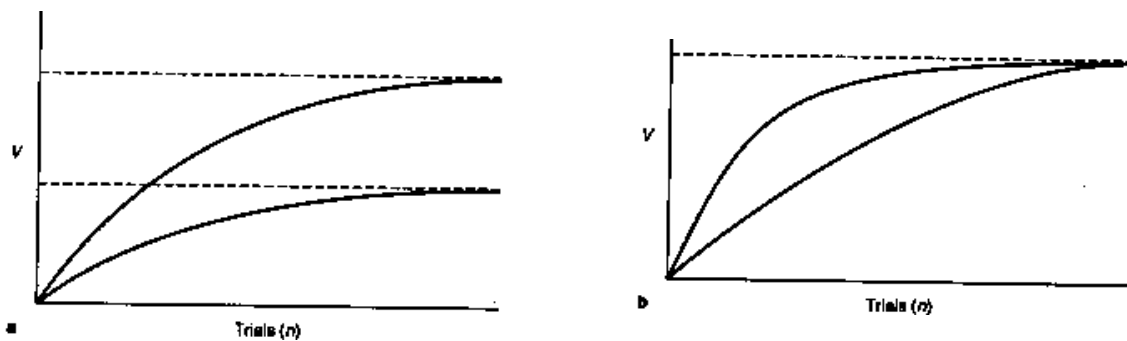


FIGURE 5.3 Variations in the asymptote (broken line) and rate of conditioning: (a) two learning curves that change at the same rate but approach different asymptotes; (b) two curves that approach the same asymptote but at different rates.

F. Problems with mathematical models (e.g., Rescorla-Wagner).

1.  $V$  represents the strength of a *theoretical* association (not a real one). How do we relate measures of overt behavior to associative strength?
2. We need to know the values of  $c$  and  $V_{max}$  before we can predict  $V$ . How do we do that?
3. Attempting to figure out real numbers for  $V$ ,  $c$ ,  $V_{max}$ , and other similar constructs had only been attempted once in the entire history of learning theory by Hull (1943) using his mathematico-deductive model. The model was eventually discarded after more than a decade of trying because it was too cumbersome and difficult to understand.
4. Solution = it is not necessary to know the exact values to test the model; use arbitrary values instead.
5. The use of arbitrary values will not allow us to make precise quantitative predictions. For example, we cannot predict how many drops of saliva will occur after 20 pairings of a TONE (CS) with a FOOD (US).
6. The use of arbitrary values will allow us to make qualitative predictions. For example, we can predict whether the amount of saliva will increase or decrease over trials.

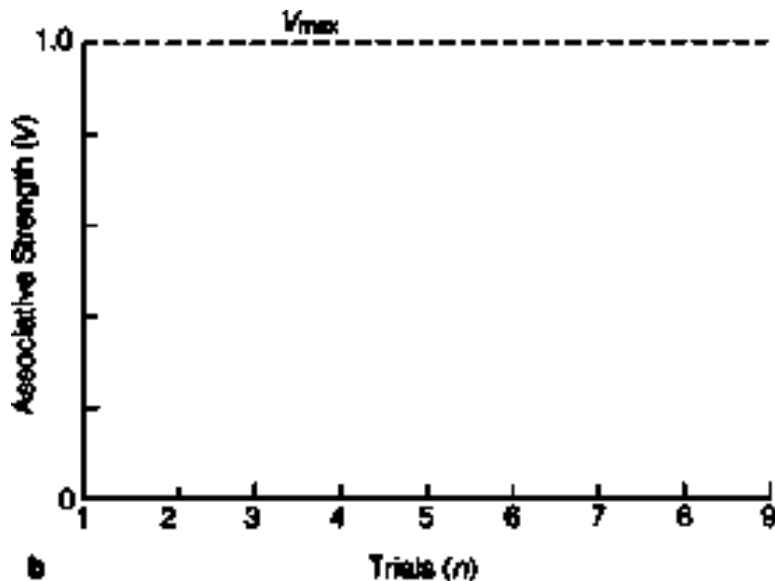
G. Tests of model.

1. Conditioning

- a. Repeatedly pair a TONE (CS) with FOOD (US).
- b. Assume  $V_{max} = 1.0$  and  $c = 0.30$ . Also assume that associative strength at the beginning of trial 1 equals zero since pairing hasn't even begun yet. That is,  $V_n = V_1 = 0.00$
- c. Plug in your values using the equation  $\Delta V_n = c(V_{max} - V_n)$ , add the change in value using the equation  $V_{n+1} = V_n + \Delta V_{n+1}$  and fill out the following table.

Trial	$V_n$	$\Delta V_n = c(V_{max} - V_n); V_{n+1} = V_n + \Delta V_{n+1}$
1	0.00	$\Delta V_1 = 0.30 (1-0.00) = +0.30; 0.00+0.30 = 0.30$
2	0.30	$\Delta V_2 = 0.30 (1-0.30) = +0.21; 0.30+0.21 = 0.51$
3	0.51	$\Delta V_3 = 0.30 (1-0.51) = +0.147 \approx 0.15; 0.51+0.15 = 0.66$
4	0.66	
5		
6		
7		
8		
9		

- d. Draw a graph using your values for  $V_n$



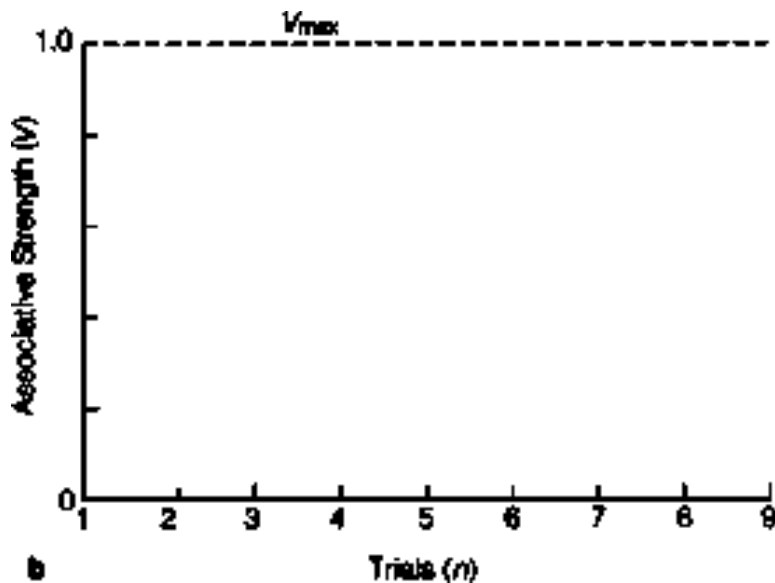
2. Extinction

- a. After repeated pairings of the CS and US, we know that the increase in level of conditioning reached approaches 0.00 (since we'd be at asymptote no new learning will occur).
- b. What happens when we no longer pair the CS and US as in extinction? You must assume  $V_{max} = 0.00$  (since no new learning can take place).
- c. Suppose after the 3rd conditioning trial we begin to present the CS alone.

Trial	$V_n$	$\Delta V_n = c(V_{max} - V_n); V_{n+1} = V_n + \Delta V_{n+1}$
1	0.00	$\Delta V_1 = 0.30 (1-0.00) = +0.30; 0.00+0.30 = 0.30$
2	0.30	$\Delta V_2 = 0.30 (1-0.30) = +0.21; 0.30+0.21 = 0.51$
3	0.51	$\Delta V_3 = 0.30 (1-0.51) = +0.147 \approx 0.15; 0.51+0.15 = 0.66$

Trial	$V_n$	$\Delta V_n = c(V_{max} - V_n); V_{n+1} = V_n + \Delta V_{n+1}$
4 CS alone	0.66	$\Delta V_4 = 0.30 (0.00-0.66) = -0.198 \approx 0.20; 0.66-0.20 = 0.46$
5 CS alone	0.46	
6 CS alone		
7 CS alone		
8 CS alone		
9 CS alone		

- d. Draw a graph using your values.



### 3. Blocking

- a. For an analysis of blocking, we have to take into consideration a compound CS (usually 2 stimuli instead of only one) = NOISE (CS<sub>a</sub>) and LIGHT (CS<sub>b</sub>).
- b. If 2 stimuli are presented together then both can predict the likelihood of the US occurring.
- c. Rescorla-Wagner Model assumes that if 2 stimuli (a and b) are presented together, the associative strength at the beginning of a trial would be equal to the sum of the strengths of each stimulus present. In other words  $V_{ab} = V_a + V_b$
- d. Assume that CS<sub>a</sub> has an associative strength of 0.30 and CS<sub>b</sub> has an associative strength of 0.50.  $V_{ab} = V_a + V_b = 0.30 + 0.50 = 0.80$ . Therefore, the associative strength of the compound CS<sub>a</sub> and CS<sub>b</sub> would be equal to 0.80.
- e. The amount of conditioning that would take place if both CS<sub>a</sub> and CS<sub>b</sub> occur together would be represented by the equation

$$\Delta V_a = \Delta V_b = c(V_{max} - V_{ab})$$

where

$$V_{ab} = V_a + V_b$$

- f. Typical blocking experiment:
  - teach animal to bar press for food
  - pair NOISE (CS<sub>a</sub>) + SHOCK (US) for many trials
  - pair compound NOISE/LIGHT (CS<sub>ab</sub>) + SHOCK (US) for many trials
  - present NOISE (CS<sub>a</sub>) while bar pressing --> RESPONSE SUPPRESSION
  - present LIGHT (CS<sub>b</sub>) while bar pressing --> NO RESPONSE SUPPRESSION
- g. During the NOISE (CS<sub>a</sub>) + SHOCK (US) trials, the associative strength of the NOISE would have increased until it reached asymptote. If we assume  $V_{max}$  for the SHOCK (US) = 1.0 then at the end of the NOISE (CS<sub>a</sub>) + SHOCK (US) trials,  $V_a = 1.0$ .
- h. If the NOISE was now presented with the LIGHT (NOISE/LIGHT CS<sub>ab</sub>) then their combined associative strength could be no more than 1.0 (since we are already at asymptote).
- g. Given that  $V_{ab} = V_a + V_b$ , and we know that CS<sub>a</sub> = 1.0 and CS<sub>ab</sub> = 1.0, what is the value of CS<sub>b</sub>?
- h. The Rescorla-Wagner Model predicts accurately that no conditioning will occur to the LIGHT (CS<sub>b</sub>) since  $V_b$  has to equal 0.00.