

Classical Conditioning: Theoretical Issues



EXP 4404

Necessary & Sufficient Conditions

- ☞ Conditions that will *always* result in an outcome.
- ☞ When any of these conditions is absent, the outcome will not occur.
- ♦ *Simmering a fresh, room-temperature egg in 212° F water for 20 min will always result in a hard-boiled egg.*

Theoretical Questions For Classical Conditioning

- ☞ What are the necessary and sufficient conditions for classical conditioning?
- ☞ What is learned during classical conditioning?

Contiguity Theory

- ☞ CS & US must co-occur in time
- ☞ Relevant Evidence:
 - ♦ *CS-US pairing is necessary but not sufficient*
 - ♦ *Equal numbers of pairings do not produce equal amounts of conditioning*
 - *Presentation of US-only trials slows conditioning*
 - *One stimulus can block conditioning of another stimulus*
 - ♦ *Is temporal pairing necessary?*
 - *Conditioning of taste aversions*

Necessary Conditions

- ☞ Conditions that *must* be present to produce an outcome
 - ♦ *if conditions are not met, the outcome will not occur*
- ☞ Presence of these conditions alone are not enough to ensure that an outcome does occur
 - ♦ *necessary conditions set the stage for the outcome but do not guarantee that it occurs*
- ☞ Clouds are necessary conditions for rain. If there are no clouds in the sky, it will not rain. There can be clouds in the sky without rain.

Contingency Theory

- ☞ A stimulus will be conditioned to a US if the probability of the US after presentation of the CS is greater than the probability of the US when the CS is absent
 - ♦ *Conditioning occurs only when the CS is a good predictor of the US*
- ☞ The stronger the predictive relation between the CS and the US, the better the conditioning
 - ♦ *Rescorla found that the predictive value of a CS was more important than the number of CS-US pairings in determining the success of conditioning*

Problems for Contingency Theory

☞ Blocking

- ♦ prior exposure to a CS blocks conditioning to a second CS
- ♦ without prior exposure, the CS-US pairings would produce conditioning

Rescorla - Wagner Model

$$\Delta V_a = \lambda (\theta - V_{ax})$$

- ΔV_a change in V_a
- V_a associative strength of CS_a (A)
- V_x associative strength of CS_x (X)
- V_{ax} associative strength of compound (A+X)
- " salience of CS
- λ intensity of the US
- θ maximum CR supported by the US
- $\theta - V_{ax}$ degree to which US is unexpected

Problems for Contingency Theory

☞ Conditioning can occur when the contingency between CS and US is zero (Durlach, 1989)

- ♦ 25% trials CS (Light) → US (Group 25)
- ♦ 25% trials CS (Light) → US + 17 trials US presented alone (Unsignaled Condition)
- ♦ 25% trials CS (Light) → US & 17 trials Tone → US (Signaled Condition)

- ☞ Group 25 has strong contingency & good conditioning
- ☞ Signaled group has weak contingency but also shows good conditioning
- ☞ Unsignaled group does not condition

Before Conditioning Begins

☞ Assume values for parameters in the model

- ♦ $V_a = 0$ $V_x = 0$ $V_{ax} = V_a + V_x = 0$
- ♦ $\theta = 100$ " = .5 $\lambda = .6$ " $\lambda = .3$

- ☞ Values are based on data from past experiments and convenience for computation with the model

Rescorla-Wagner Model

- ☞ Modified version of contingency theory
- ☞ Conditioning only occurs when the US is unexpected
- ☞ Only stimuli that precede a US and predict the onset of the US can be conditioned
- ☞ Breaking the predictive relation between the CS and US will result in a loss of the CR
- ☞ Conditioning of a CS depends on the role of other stimuli that are also present

Values Computed After the First CS - US Pairing

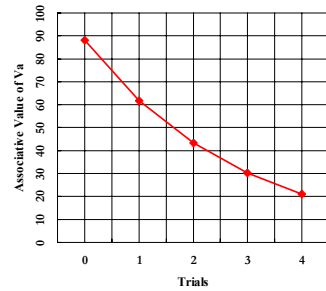
$$\Delta V_a = \lambda (\theta - V_{ax})$$

$$\Delta V_a = .3 (100 - 0)$$

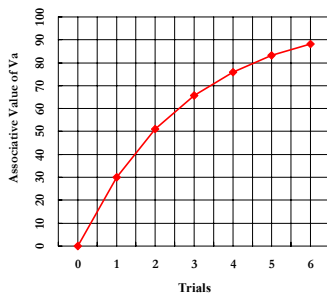
Value for V_a is Recomputed after each CS-US Pairing

Trial	V_a	new value for $V_a = V_a + \beta(V_{US} - V_a)$
1	30	30
2	21	51
3	14.7	65.7
4	10.29	75.99
5	7.20	83.19
6	5.04	88.23

Extinction of a Conditioned Response



Acquisition of a Conditioned Response



Overshadowing: Competition Among CSs

Assume values for parameters in the model

- $V_a = 0$ $V_x = 0$ $V_{ax} = V_a + V_x = 0$
- $\beta = 100$
- FOR CS A: " = .5 \$ = .6 " \$ = .3
- FOR CS X: " = .2 \$ = .6 " \$ = .12

Extinction

No US is present, so $\beta = 0$

$$V_a = \beta(V_{US} - V_a)$$

$$V_a = 0(0 - 88.23)$$

Trial V_a new value for $V_a = V_a + \beta(V_{US} - V_a)$

1	-26.469	61.761
2	-18.528	43.233
3	-12.970	30.263
4	-9.079	21.184

Values Computed After First CS - US Pairing

$$V_a = \beta(V_{US} - V_a)$$

$$V_a = .3(100 - 0)$$

$$V_x = .12(100 - 0)$$

Value for V_a Computed after each CS-US Pairing Trial

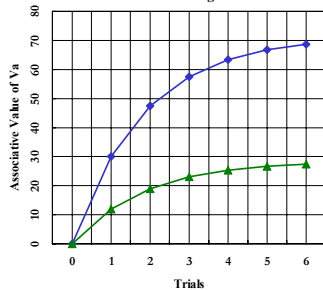
$$V_a = \alpha (8 - V_{ax})$$

Trial	V_a	V_x	V_{ax}
1	30	12	42
2	17.4	6.96	66.36
3	10.1	4.04	80.5
4	5.85	2.34	88.74
5	3.34	1.35	93.43
6	1.97	0.79	96.19

Wagner's Priming Theory

- ☞ Introduction of cognitive mechanisms to explain classical conditioning
- ☞ Assumes that stimuli can persist in memory after they are no longer present in the environment
- ☞ Contiguity of the CS and the US *in the memory system* is important for conditioning
- ☞ Factors that change the amount of rehearsal in memory (like surprise) influence conditioning

Competition Between Stimuli for Associative Strength



Behavior Systems Theory (Timberlake)

- ☞ Examines the role of biology & instinctive behavior in conditioning
 - ♦ *mating*
 - ♦ *feeding*
 - ♦ *defense*
- ☞ Different behavior systems increase sensitivity to particular stimuli & bias direction of behavior
 - ♦ *feeding system most sensitive to tastes*
 - ♦ *defense system most sensitive to sounds and sights*

Role of "Surprise" in Rescorla-Wagner Model

- ☞ **Blocking**
 - ♦ occurs because US is already predicted by a CS
 - ♦ pairing a new CS with the US fails to produce conditioning because the organism does not improve its ability to predict the US by learning a new CR
- ☞ **US pre-exposure**
 - ♦ no effect on conditioning if training occurs in a NEW environment
 - ♦ slowed conditioning if training occurs in the same environment as the pre-exposure

What is Learned During Classical Conditioning?

- ☞ Stimulus - Stimulus Associations
- ☞ Stimulus - Response Associations

Response Prevention Experiments

- ⌘ What happens if the UR is blocked?
- ⌘ If the response is not paired with the CS, can the CS come to elicit the response as a CR?

- ⌘ Temporarily eliminate a motor response (e.g., leg flexion) to a US (shock)
- ⌘ Test for a CR after recovery of motor movement

- ⌘ Has the UR actually been eliminated during training?

What is the Effective CS?

- ⌘ Context can also serve as a CS

- ⌘ Considering the context and the nominal CS as a compound stimulus can help explain some conditioning phenomena
 - ◆ *blocking*
 - ◆ *US pre-exposure effects*

Sensory Preconditioning Experiments

- ⌘ Look for conditioning when no overt UR is observed
 - ◆ 1. *CS1 (tone) - CS2 (light)*
 - ◆ 2. *CS2 (light) - US (shock) → Fear*
 - ◆ 3. *Test: CS1 (tone) → ???*
(observe fear response)
- ⌘ suggests an S - S association

Other Evidence for S-S Associations

- ⌘ CR acquired depends on characteristics of the CS as well as the US used during conditioning
 - ◆ *Holland (1977)*
 - ◆ *US -- delivery of food*
 - ◆ *CR -- increased activity when CS was a tone*
 - ◆ *CR -- decreased activity when CS was a light*
- ⌘ Changes in the US after conditioning has taken place will produce changes in the CR
 - ◆ *e.g., stimulus devaluation experiments*