Classical Conditioning: Theoretical Issues

EXP 4404

Theoretical Questions For Classical Conditioning

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

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.

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.*

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*

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*

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

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

Rescorla - Wagner Model

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

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)
α	salience of CS
β	intensity of the US
λ	maximum CR supported by the US
$\lambda - V_{ax}$	degree to which US is unexpected

Before Conditioning Begins

- Assume values for parameters in the model
  - *Va = 0 Vx = 0 Vax = Va + Vx = 0*
  - *λ = 100 α = .5 β = .6 αβ = .3*
- Values are based on data from past experiments and convenience for computation with the model

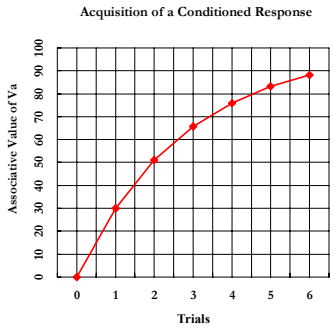
Values Computed After the First CS - US Pairing

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

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

Value for V_a is Recomputed after each CS-US Pairing

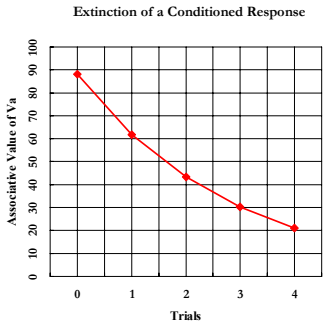
Trial	ΔV_a	new value for $V_a = V_a + \Delta V_a$
1	30	30
2	21	51
3	14.7	65.7
4	10.29	75.99
5	7.20	83.19
6	5.04	88.23



Extinction

- No US is present, so $\beta = 0$
  - $\Delta V_a = \alpha\beta(\beta - V_{ax})$
  - $\Delta V_a = .3(0 - 88.23)$

Trial	ΔV_a	new value for $V_a = V_a + \Delta V_a$
1	-26.469	61.761
2	-18.528	43.233
3	-12.970	30.263
4	-9.079	21.184



Overshadowing: Competition Among CSs

- Assume values for parameters in the model
  - *Va = 0 Vx = 0 Vax = Va + Vx = 0*
  - *8 = 100*
  - *FOR CS A: " = .5 $ = .6 "$ = .3*
  - *FOR CS X: " = .2 $ = .6 "$ = .12*

Values Computed After First CS - US Pairing

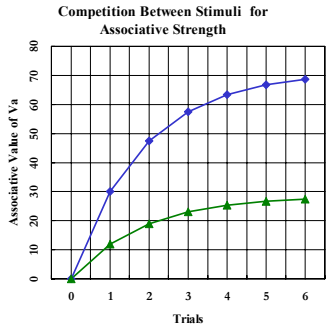
$$\Delta V_a = \alpha\beta(\lambda - V_{ax})$$

$$\Delta V_a = .3\,(100 - 0)$$
$$\Delta V_x = .12\,(100 - 0)$$

Value for V_a Computed after each CS-US Pairing Trial

$\Delta V = \alpha\beta(\lambda - V_{ax})$

Trial	ΔV_a	V_a	ΔV_x	V_x	V_{ax}
1	30	30	12	12	42
2	17.4	47.4	6.96	18.96	66.36
3	10.1	57.5	4.04	23	80.5
4	5.85	63.4	2.34	25.34	88.74
5	3.34	66.74	1.35	26.69	93.43
6	1.97	68.71	0.79	27.48	96.19



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*

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

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*

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?

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*

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*