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.

- Conditioning can occur when the contingency between CS and US is zero (Durlach, 1989)
  - 25% trials CS (Light) $\rightarrow$ US (Group 25)
  - 25% trials CS (Light) $\rightarrow$ US + 17 trials US presented alone (Unsignaled Condition)
  - 25% trials CS (Light) $\rightarrow$ US & 17 trials Tone $\rightarrow$ US (Signaled Condition)

- Group 25 has strong contingency & good conditioning.
- Signaled group has weak contingency but also shows good conditioning.
- Unsighaled 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

\[ \Delta V_a = 8 - V_{ax} \]

- \( V_a \): 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)
- \( \text{s} \): salience of CS
- \( 8 \): intensity of the US
- \( 8 - V_{ax} \): degree to which US is unexpected

Before Conditioning Begins

Assume values for parameters in the model

- \( V_a = 0 \)
- \( V_x = 0 \)
- \( V_{ax} = V_a + V_x = 0 \)
- \( 8 = 100 \)
- \( \text{s} = .5 \)
- \( \beta = .6 \)
- \( \text{z} = .3 \)

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

Values Computed After the First CS - US Pairing

\[ \Delta V_a = 8 - V_{ax} \]

\[ V_a = .3 (100 - 0) \]
Value for $V_a$ is Recomputed after each CS-US Pairing

- Trial 1: $V_a = 30$
- Trial 2: $V_a = 51$
- Trial 3: $V_a = 65.7$
- Trial 4: $V_a = 75.99$
- Trial 5: $V_a = 83.19$
- Trial 6: $V_a = 88.23$

Acquisition of a Conditioned Response

- Extinction
  - No US present, so $B = 0$
  - $V_a = \frac{4}{3}(B - V_a)$
  - $V_a = 0.3(0 - 88.23)$

- Trial 1: $V_a = 26.469$
- Trial 2: $V_a = 43.233$
- Trial 3: $V_a = 30.263$
- Trial 4: $V_a = 21.184$
Overshadowing: Competition Among CSs

1. Assume values for parameters in the model
   - $V_a = 0$
   - $V_x = 0$
   - $V_{ax} = V_a + V_x = 0$
   - $B = 100$
   - FOR CS A: $w = .5$, $g = .6$, $g = .3$
   - FOR CS X: $w = .2$, $g = .6$, $g = .12$

Values Computed After First CS - US Pairing

1. $V_a = g (B - V_{ax})$
2. $V_a = .3 (100 - 0)$
3. $V_x = .12 (100 - 0)$
Value for $V_{a}$ Computed after each CS-US Pairing Trial

$$V = \psi(\theta - V_{a})$$

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<th>Trial</th>
<th>$V_a$</th>
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<th>$V_s$</th>
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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