Chapter 7 - Operant Conditioning

Schedules and Theories of Reinforcement

Lecture Outline

• Schedules of reinforcement
  – Continuous vs. intermittent schedules
  – Four basic intermittent schedules
  – Other simple schedules of reinforcement
  – Complex schedules of reinforcement

• Theories of reinforcement
  – Drive reduction theory
  – The Premack principle
  – Response deprivation hypothesis
  – Behavioral bliss point approach
Now that we have discussed reinforcement.

- It is time to discuss how reinforcements can and should be delivered.
- In other words, there are other things to consider than just what the reinforcer should be.
- If you were going to reinforce your puppy for going to the bathroom outside, how would you do it?
  - Would you give him a doggie treat every time? Some of the time?
  - Would you keep doing it the same way or would you change your method as you go along?

Schedules of Reinforcement

- A schedule of reinforcement is

  - Each particular kind of reinforcement schedule tends to produce a

  - In other words, it is what you have to do to get the reward!
    - Example: Does a dog have to roll over just once to get a reward, or does he have to roll over more than once before he’s given his reward?
Continuous vs. Intermittent Reinforcement

• **Continuous**
  – A *continuous reinforcement schedule (CRF)* is one in which
    • Example: every time the dog rolls over he gets a treat
every time a child hangs up her coat she gets praised
  – Useful for strengthening newly learned behaviors or when using shaping procedures to train a behavior.
  – Leads to
  – Not very common in a natural environment.

• **Intermittent**
  – An *intermittent reinforcement schedule* is one in which
    • Example: every third time the dog rolls over he gets reinforced.
  – Useful for
  – They can be based on the number of responses made (ratio) or the time between reinforcement (interval)
  – They can also be fixed or variable.
## Four Basic Types of Intermittent Schedules

<table>
<thead>
<tr>
<th>Ratio Schedules</th>
<th>Interval Schedules</th>
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</thead>
<tbody>
<tr>
<td>Fixed Ratio</td>
<td>Fixed Interval</td>
</tr>
<tr>
<td>Variable Ratio</td>
<td>Variable Interval</td>
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### Fixed Ratio Schedule

- **Fixed ratio schedule (FR)** - reinforcement is given after a

- Examples:
  - FR4 schedule - a salesperson receives a bonus after every 4 sales
  - FR1 schedule - take a break after reading a chapter in the text
  - FR50 schedule - a rat received a food pellet after every 50 bar presses.
  - “piecework” - paid by number of pieces sewn together

- Schedules can be...
Fixed Ratio Schedule

- Characteristic pattern:
  - 
  - 
- Higher ratio requirements produce
  - e.g., FR50 has longer break before responding again than FR25
- Can stretch the reinforcement ratio (e.g., FR1, FR2, FR4, FR6, FR10)
- Ratio strain – when requirement increases too quickly behavior becomes
  - Movement from “dense” to “lean” schedules should be done gradually.

Variable Ratio Schedule

- **Variable Ratio (VR):** Reinforcer given after

  - VR10 schedule, on average every 10 responses are reinforced but number of responses might vary between 1 and 20
  - Examples
    - VR6 schedule - a gambling machine pays off every 6 spins on average, but payoff trial cannot be predicted
    - VR50 schedule - a food pellet is dispensed on average every 50 bar-presses, but exact trial cannot be predicted
    - Salesperson working on commission
Variable Ratio Schedule

- Characteristic pattern:
  - 
  - 

Other facts about Variable Ratio Schedules

- Behaviors on this type of schedule tend to be
  - This includes unwanted behaviors like begging, gambling, and being in abusive relationships
  - “Stretching the ratio” means starting out with a very dense, rich reinforcement schedule and

- The spouse, gambler, or child who is the “victim” must work harder and harder to get the reinforcer
Four Basic Types of Intermittent Schedules

- **Ratio Schedules**: reinforcement given after a number of non-reinforced responses
  - Fixed Ratio
  - Variable Ratio

- **Interval Schedules**: reinforcement given for a responses that occurs after a certain amount of time has passed
  - Fixed Interval
  - Variable Interval

Fixed Interval Schedule

- **Fixed Interval (FI)**: Reinforcement obtained on

  - Example
    - FI 2min – a rat receives food on the first lever press following a 2 minute interval
    - FI 75min - glancing at the clock during class. After 75 minute interval, you are rewarded by being allowed to leave.
Fixed Interval Schedule

• Characteristic Pattern:
  – “scallop pattern” - FI schedules produce an upwardly curved rate of responding

  • Example: study more and more as a test approaches.
  – noticeable

  • Example: don’t study much after a test has just occurred.

Variable Interval Schedule

• **Variable Interval (VI):** Reinforcer given for the

  – VI 30 sec schedule- on average the first response after every 30 seconds is reinforced but the time of reinforcement might vary between 1 sec & 1 min

  – Examples
    • VI 2min - a food pellet is dispensed on the first bar-press following a 2 minute interval (on average) but exact time bar-press cannot be predicted
    • VI 15min – Hilary’s boyfriend, Michael, gets out of school and turns on his phone some time between 3:00 and 3:30 (the average is after 15 minutes) – the “reward” of his answering his phone puts her calling behavior on a VI schedule, so she calls every few minutes until he answers
Variable Interval Schedule

- Characteristic Pattern:
  - Moderate steady rate of response
  - little or no post-reinforcement pause

- Example: Presses of the "redial" button on the telephone are sustained at a steady rate when you are trying to reach your parents and get a "busy" signal on the other end of the line.

Patterns of Responding

<table>
<thead>
<tr>
<th></th>
<th>FR</th>
<th>VR</th>
<th>FI</th>
<th>VI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response rate</td>
<td>High</td>
<td>High</td>
<td>Increasing</td>
<td>Moderate</td>
</tr>
<tr>
<td>Post reinforcement pause</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
</tr>
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</table>
Practice Identifying Schedules of Reinforcement

• Students' visits to the university library show a decided increase in rate as the time of final examinations approaches.

• Every time you put money in the vending machine you receive your candy bar.

• Fred has a boss who checks on his work periodically (usually roughly every 2 hours). Because Fred doesn’t know exactly when the next ‘check-up’ might come, he generally works hard at all times in order to be ready.

• You have to email your friend Bob about 3 times before he’ll email you back. After your third email on average, though, he usually responds.

Other Simple Schedules of Reinforcement

• Response rate schedules

• Non-contingent schedules
Other Simple Schedules of Reinforcement

• Response rate schedules
  – Intermittent schedules of reinforcement produce different patterns of responding
  – With a response rate schedule, reinforcement is directly related to
    • DRH
    • DRP
    • DRL
    • DRI
    • DRO
  – Differential reinforcement –

Response rate schedules

• Differential reinforcement of high rate (DRH)
  – A minimum number of responses
  – Reinforcement is contingent on
  – Maintains a high rate of responding (higher than any other schedule used)
  – Examples
    • A rat receives food if it performs 60 lever presses in a one minute period
    • A child is taken to the movies if he tidies up all of his toys within 10 minutes
Response rate schedules

• Differential reinforcement of paced responding (DRP)
  – Responses are reinforced only if responding
  – Reinforcement is provided for responding at a rate that is
  – Example
    • Reinforce a rat for 10 consecutive bar-presses if each is separated by an interval of between 1.5 s and 2.5 s
  • In autism too little eye-contact during social interactions is problematic; but don’t want too much eye contact because it might be perceived as threatening. Reinforce eye-contact behavior if it occurs at an appropriate rate during a social interaction.

Response rate schedules

• Differential reinforcement of low rate (DRL)
  – Responses are reinforced only if
  – Maximum number of responses during the time period are rewarded
  – Encourages
  – Used to reduce the frequency of a behavior
  – Useful when some of the behavior is tolerable but less would be better
  – Example
    • Calling out correct answers in class is rewarded if it only occurs once every 15 minutes
Response rate schedules

- **Differential reinforcement of zero behavior (DRO)**
  - Reinforced if specified period has elapsed
  
  - Also called differential reinforcement of other responding
  - Used to
  - Example
    - Reward a child if she has not sucked her thumb in 60 seconds
    - Reward a child for sustaining on-task behavior for 5 minutes

Response rate schedules

- **Differential reinforcement of incompatible behavior (DRI)**
  - Similar to DRO, but rewarded for performing a behavior that is
  
  - Used to
  - Example
    - If trying to eliminate disruptive classroom behavior
    - Reward a child for sitting quietly
Other Simple Schedules of Reinforcement

- Non-contingent schedules of reinforcement
  - Reinforcer is obtained

  - Two basic types:
    - Fixed time schedule
    - Variable time schedule

Non-contingent schedules - Fixed Time Schedule

- Fixed time schedule
  - Reinforcer is delivered

Example
Reward a child with a trip to the movies once a week irrespective of whether she has been good or bad (FT 1-week schedule)
Non-contingent schedules - Variable Time Schedule

- Variable time schedule
  - Reinforcer is delivered following

Example
Reward a child with a trip to the movies on average once a week irrespective of whether she has been good or bad (VT 1-week schedule). The interval might vary between 1 day and 3 weeks

Non-contingent schedules - superstitious behavior

- What happens when reinforcement occurs randomly, regardless of a person or animal’s behavior?
- Weird Stuff! - Superstitious behaviors
Superstitious Behavior

- Ono (1987)
  - Ps presented with 3 levers and a counter
  - Told “if you do something you might get points on the counter”
  - Not told what to do
  - Points delivered on FT or VT schedule (the exact behavior that produced the reward was unknown)
  - e.g., lever pulling in set sequences; touching the counter; pulling lever then jumping
  - Also seen in animal studies (spinning in circles, visiting all 4 corners of the cage, etc.)
- Might also explain superstitious behavior in gamblers, sports people (rituals before free-throws)

Non-contingent schedules - poor performance

- Non-contingent reinforcement
  - Rachlin & Baum (1972)
  - Pigeons responding on a VI schedule for food (contingent reinforcement) also given non-contingent food reinforcements
  - Compared to control group (other pigeons on the VI schedule given the same quantity of food), the non-contingent reinforcement group responded less
  - Athletes on long-term contracts
Non-contingent schedules - good uses

• Giving noncontingent attention to children
  – Some bad behaviors like tantrums are used to try to get attention from caregivers
  – These behaviors can be diminished by giving attention noncontingently

• Children need *both* contingent AND non-contingent attention to grow up healthy and happy.

Complex Schedules of Reinforcement

• Complex schedules are combinations of two or more simple schedules
  – Conjunctive schedules
  – Adjusting schedules
  – Chained schedules
Complex Schedules - Conjunctive

- Conjunctive schedules
  - Requirements of

- Example 1
  - A rat performs a bar-pressing task for a food reinforcer on a FR50 FI 1 min schedule. The reinforcer is contingent upon the rat performing 50 bar-presses and at least one bar-press following a 1 minute interval

- Example 2
  - A student gets a high distinction on a learning and behavior course because she does well on the assignments and studies hard for the exam

Complex Schedules - Adjusting

- Adjusting schedules
  - Response requirement changes a function of

- Example 1
  - A rat performs a bar-pressing task for a food reinforcer on a FR50 schedule. If the rat completes the bar-pressing task in 2 minutes, an FR70 schedule is employed so that 70 bar-presses are required in 2 minutes

- Example 2
  - A student writes a 1000 word lab report for a first year assignment. Because the report met the required standard (i.e., the student passed the course) a 2500 word report is a requirement for a second year course.
Complex Schedules - Chained

- Chained schedules (chaining)
  - A sequence of 2 or more simple schedules each of which has its own $S^D$ and the last of which results in the terminal reinforcer

<table>
<thead>
<tr>
<th>VI 30-sec</th>
<th>VR20</th>
<th>FI 30-sec</th>
</tr>
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<tbody>
<tr>
<td>White Key: Peck $→$ Green Key: Peck $→$ Red Key: Peck $→$ Food</td>
<td></td>
<td></td>
</tr>
<tr>
<td>$S^D$ $→$ R $→$ $S^R/S^D$ $→$ R $→$ $S^R/S^D$ $→$ R $→$ $S^R$</td>
<td></td>
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- The keys act as discriminative stimuli
- The red and green keys act as

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Complex Schedules - Chained

- **Goal gradient**
  - Increase in
  - Responses in the early part of the chain are

- Easy to observe if each link consists of the same reinforcement schedule

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- Slower rate of response and longer pauses on white key than green; strongest response on red key
- Terminal reinforcer is
- Earlier links
Complex Schedules - Chained

- *Backward chaining*
  - To establish a chained schedule

  - Can also have a chained schedule where each link in the chain consists of a *different* response

\[
\text{Barrier : Climb Over Barrier } \rightarrow \text{ Tunnel : Run Through Tunnel } \rightarrow \text{ Food}
\]

\[
S^D \quad \text{R} \quad S^R/S^D \quad \text{R} \quad S^C
\]

- Example
  - To train a child to dress himself.
    - Day 1 - shoes on $\rightarrow$ reward
    - Day 2 - socks on, shoes on $\rightarrow$ reward
    - Day 3 - pants on, socks on, shoes on $\rightarrow$ reward
    - Day 4 - undies on, pants on, socks on, shoes on $\rightarrow$ reward