ANNOUNCEMENTS:

Midterm 1 is on January 28 (Monday). The review session is, tentatively, on February 1st (Monday) at 5 PM. Read only through Skinner for the first test.

Last Lecture: Tolman and Spence

Lecture: Key Words
I. Burrhus F. Skinner (1904–1990)
Operant Conditioning
"Skinner Box"
Emitted vs. Elicited Behavior
Skinner Box Parts
1) Manipulandum
2) Relay (Produces Audible Click/Pellet Releasing Mechanism)
3) Food Tray
4) Event Recorder (Cumulative)

I. Skinner

Skinner is much more of an empiricist than a theoretician. He was aware of Pavlovian ideas and was interested in the notion of reflex (i.e. US>UR). Skinner also wanted to look at behavioral correlates.

A. Operant Conditioning

1. Recall that in classical conditioning the animal is always restrained. In instrumental learning, however, the animal is free to move about. Operant conditioning is part of instrumental learning. Operant means to perform work or labor. Within this paradigm, you measure the amount of work an animal does for a reinforcer. After training the animal, you are trying to bring its behavior under control. This procedure involves the passive recording of the behavior of individual animals.

B. Elicit vs. Emit

1. Most previous researchers, including Thorndike, Hull, and Tolman, believed that stimuli elicit behavior. Skinner
downplays the idea of stimulus and postulates instead that behavior is emitted. When an animal works for a reward it is emitting behavior. The operant is emitted, rather than elicited, and it is controlled by its consequences. In the Pavlovian procedure the response, now called a "respondent" is elicited and is controlled by its eliciting stimulus. This then becomes the fundamental difference in the two procedures (i.e. operant vs. classical conditioning).

ex.

\[ S-R-S^* \] (food reward)
stimuli elicit behavior

\[ R-S^* \]
behavior is emitted to get reward

ex. T-maze

\[ R-S^* \]

\[ \rightarrow \text{O food} \]

work for food = operant

ex. slot machine

Is behavior emitted for a reward or does the slot machine elicit behavior?

Elicit is used in classical conditioning.
Emit is used in operant conditioning.

C. **Skinner Box**

1. Skinner box parts
Manipulandum=lever or key
Front panel where animal goes to press bar=intelligence panel

Paper record
(taken from drum)
Behavior doesn't mean anything unless you have a record of the event.
2. Rate of Response
   a) The cumulative record is simply one of many ways in which the occurrence of the response in time may be recorded, but it enables the experimenter to see perhaps more easily than with any other presentation the rate at which the response occurs.

Slide 46-WGTA-apparatus like Spence used in training his monkeys.
Slide 47-transposition shifts
Slide 48-2 choice problem
Slide 49-peak shift
Slide 50-3 choice test
Slide 51-Skinner Box (outside view)
Slide 52-Skinner Box (inside view)
Slide 53-rat pressing lever for water
Slide 54-paper record
Slide 55-Drawing representing a cumulative record of the experimental extinction of an operant response.

D. Successive Approximation
   1. You slowly get the animal to move in a certain way in order to get food.
ex. Skinner Box (make animal aware that food is associated with the box)

Steps
1) put food on floor in front of intelligence panel
2) put food in dish
3) tape food above bar
4) animal connects food coming with bar pressing
ANNOUNCEMENTS:

The midterm is on Friday, February 5th. The review session will be on Monday, February 1st from 5-7 PM in 146 Olson (same room). New readings for part 2 of this course will be available in CN on Monday, February 1st.

Last Lecture: We started Skinner.

Lecture: Key Words
I. Skinner
   Cumulative Record
   Rate of Responding
   Positive/Negative Reinforcers (Punishment)
   Secondary Reinforcers (Conditioned Reinforcers)
   Schedules of Reinforcement
      1) Fixed Ratio (FR)
      2) Variable Ratio (VR)
      3) Fixed Interval (FI)
      4) Variable Interval (VI)
   Superstitious Behavior
   Discrimination Training
      1) Error Training (S+, S−) (Peak Shift)
      2) Errorless Training (S+, S−) (No Peak Shift)

I. Skinner
   A. Review of Skinner Box
      ex. pigeon inside box—pecks keys for reward
1) reinforcement emits behavior
2) successive approximation is used to shape the pigeon's behavior (i.e. get the pigeon to peck the key for food reward reliably)

B. Schedules of Reinforcement
You first need to drop the rat's weight by 15-20% to keep them hungry. Hungry rats perform optimally in an operant context. It's important to gain control of the animal. Once you have control of the animal's response, you want to look at the rate of responding on the cumulative record.

1. Fixed Ratio (FR)
You decide in advance that you will give a reward (food pellet) for a certain number of bar presses. This number or ratio is fixed.
ex. pellet / presses
   1:10
   1:50
   1:100

2. Variable Ratio (VR)
The ratio of responses to reward varies over the trial, but researchers usually set up a schedule with a fixed average ratio. In other words, the animal gets rewarded for an average number of presses per trial.
ex. You set the average at 1 pellet for every 35 presses (1:35). You then randomize a set of ratios (pellet / presses) - 1:5, 1:60, 1:35, 1:15, etc. - to make reward unpredictable.

3. Fixed Interval (FI)
You decide in advance to give a pellet per unit time, for some particular fixed time interval.
ex. pellet / minutes
   1:10
   1:15
   1:20

ex. scalloping

Only with fixed interval schedules, the animal learns to wait until it is almost time to get food then begins
to work hard with vigorous pressing. This produces a "scalloping" effect as illustrated above.

4 Variable Interval (VI)
The time interval between rewards is varied, but researchers usually set up a schedule with a fixed average interval.

ex. Randomize a set of intervals
   1:15, 1:25, 1:7, etc.
   Set mean=1 pellet for every 15 minutes (1:15)
The highest response rate and fastest extinction occurs with fixed ratio schedules. The lowest response rate and slowest extinction occurs with variable interval schedules.

C Secondary Reinforcers

ex. rat in Skinner Box (light predicts food)

ex. schematic: animal can use click of relay to predict food reward

Food is the primary reinforcer. The click or light are secondary reinforcers. The animal "wants" to see the light or click because it then knows that food is on the way. The click takes on the properties of food. Anything that maintains behavior is a reinforcer.

ex. behavior modification in disturbed children
You are trying to get eye contact (primary reinforcer) by giving the child a hug (secondary reinforcer). Eye contact is such an aversive primary reinforcer in these children, though, that the secondary reinforcer (hug)
doesn’t work for very long.

D. **Positive and Negative Reinforcers**

1. Definitions
   a) A **reinforcer** is something that increases the rate of responding.
   b) A **positive** reinforcer is something whose presence increases the rate of responding.
   c) A **negative** reinforcer is something whose removal increases the rate of responding.

2. Procedure
   - ex. Punish rat with shock paired with tone to get negative reinforcement.

   ![Diagram](image)

   **TONE CS**
   ![Shock](image)

   **LATEN**
   **TONE IS PRESENTED IN SKINNER BOX AND DISRUPTS LEVEL PRESSING. ITS REMOVAL ENGENDERS RESUMPTION OF BAR PRESSING**

   When you pair tone with shock and present them to the animal together, the animal stops pressing. After several trials, when you present the tone alone, the animal stops pressing.

   - ex.

   ![Diagram](image)

   **Tone**
   ![Apply](image)

   **Tone stops when negative reinforcement is removed**

   When you apply the tone, the rat stops pressing. Remove the tone, and the rat starts pressing again.

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**slide 55**-drawing representing a cumulative record of the experimental extinction of an operant response.

**slide 56**-operant conditioning and extinction.

**slide 57**-performance curves of three animals under fixed ratio schedules.

**slide 58**-four schedules of reinforcement, fixed and variable ratio schedules produce good performance, fixed interval produces scalloping, variable interval is worst. When you
look at these graphs, remember that a steep slope indicates increased responding and a gradual slope indicates decreased responding.

slide 59—pigeon response curves, fixed ratio is best.
slide 60—mixed performance curves, occurs when animal is trained with different schedules and with different stimuli.
slide 61—cumulative record of 4 schedules of reinforcement.
slide 62—variable interval reinforcement.
slide 63—experimental extinction of running speed in an alley resulting from different percentages of partial reinforcement during training.
slide 64—rate of bar pressing as a function of motivation and schedule of reinforcement. Increased hunger leads to increased performance.
slide 65—Skinner Box
slide 66—Skinner Box for pigeons
slide 67—train pigeon to discriminate

E. Discrimination Training

1. Test for perceptual abilities of animals
   ex. pigeon in Skinner Box (projector with colored slides)

2. error training
   ex. schematic

  -> Lighted Key (Green) $S^+$

  Train Peck

  ex. graph
This is error training because it's differential, the animal is on only 1 color and it makes mistakes. i.e., rewarded on green ($S^+$) not rewarded on yellow ($S^-$).

ex. 2 keys—randomized positions

$S^+$=green  $S^-$=yellow

Food reward is given only when green light is pecked. After many trials, you test and find out that the animal can discriminate between yellow and green.
The midterm is on Friday, February 5th. The review session will be from 5-7 PM on Monday, February 1st in 146 Olson. You are only responsible for the material through Skinner for this test. The midterm will be multiple choice so bring a #2 pencil and a #882 Scantron to the test.

**Last Lecture:** Skinner. Know the schedules of reinforcement and how they affect performance.

**Lecture:** Key Words

I. Skinner

Superstitious Behavior (FI schedule)

Non-differential Training

Discrimination Training

- Error Training (Peak Shift)
- Errorless Training (No Peak Shift)

Shaping

Chaining (S-R units)

$SD = S^+$ (Conditioned Reinfocer-i.e. secondary reinforcer)

- The D refers to a discriminable stimulus

I. Skinner

A. **Review Error (Non-differential) Training**

   - ex. pigeon in Skinner Box

   ![Ex. schematic](image)
lighted key $(S^+ = \text{green})$
- peck key
- food

This procedure is not very good in training discrimination.

ex. schematic

This is after at
aching
discrimination.

ex. graph

There is a peak shift away from red because inhibition is built up by the animal. Frustration occurs with the color red because it is associated with a lack of reward. Animals which are given tranquilizers prior to the test don't show a peak shift, indicating that frustration is the underlying cause of the shift.

B. Errorless Training

ex. Terrace

The red light starts out dim, then gets brighter and
brighter with each trial. Because it's presented gradually, the pigeon learns to ignore the color red. The pigeon's attention is on green and it doesn't make mistakes with the red light because it's dimly lit at first.

ex. $S^+=$vertical bars  $S^- =$horizontal bars

You start out the same way as before, with bright green lights and dim red lights. Again you gradually increase the intensity of the red light. After several trials, you gradually fade out the colors and dim the lights until only the bars are showing. The pigeons learn to discriminate vertical bars and ignore horizontal bars.

There is normally no peak shift with errorless training. When you shock the animal along with the presentation of the $S^-$, however, the animal will show a peak shift. The reason for the return of the peak shift is that pairing shock with $S^-$ allows the animal to build up inhibition and frustration as in error training. Discrimination is taught more quickly with errorless training. In the previous examples, $S^D = S^+$. The green light is the discriminable stimulus.

C. Applications—Shaping and Chaining

1. In 1944, Skinner's lab was awarded a large grant to design a guided missile. The missile was to be shot from a plane at a ship below. Skinner's design was to have a pigeon in the missile pecking at a projection of a ship on a screen. In this way, the missile could supposedly follow the ship wherever it went. This design was never actually used.

2. Helicopters used Skinnerian methods to locate downed fliers. The pigeon was mounted in a box on the side of the helicopter. Whenever the pigeon saw a dye mark, it would peck at a key. The key was connected to a panel inside the chopper. Since the dye mark indicated a downed flier, the helicopter crew could find and rescue them based on the signal from the pigeon's peck. This method was actually used with limited success.
3. The entertainment business also takes advantage of operant conditioning techniques. An animal's behavior is trained with shaping and chaining.

ex. SD-R SD-R SD-R units

These are units. Shaping is changing a behavior within a unit. Chaining is linking S-R units together in a series. Each step is reinforced until a whole series of behaviors are produced. Some subsets (units) can be faded out and others added.

ex. dolphin training
The dolphin is first taught to go to the trainer and get food when it hears a whistle. This is a unit. Several other units are chained by reinforcement and successive approximation. Finally, a complex act, like doing a backflip is produced. It is very hard to extinguish the basic unit, in this case the whistle-food unit. The animal gets very frustrated when it no longer receives a reward for responding to the whistle. Perhaps this increased arousal maintains errors.

slide 68—stimulus generalization gradients
slide 69—generalization gradients under 3 different conditions

D. Superstitious Behavior
1. Skinner walked into his lab one day and discovered his pigeons doing strange behaviors and postures. The food delivery system was malfunctioning, dispensing food on a fixed interval schedule even though the animal had not made the appropriate response. As a result, the pigeon associated its particular posture or behavior at a certain interval with receiving food. These are called superstitious behaviors because the postures or behaviors adopted by the birds had nothing to do with receiving the reward.