Three basic kinds of simple learning are described in asgn3a through asgn3g:

- Habituation (asgn3a)
- Classical (or Pavlovian) conditioning (asgn3a-c)
- Instrumental (or operant) conditioning (asgn3d-g)

Habituation refers to learning that a new stimulus does not mean anything and does not need your attention. For example, a new house may have odd creaking sounds, which you notice when you first move in, but quickly ignore when it signifies nothing.

Pavlovian (or classical) conditioning refers to learning the association between two stimuli. Many people have heard of Pavlov, who conditioned dogs to salivate when a bell rang by following the sound with the taste of food. Pavlovian conditioning is easiest to see in motivation and emotion. It plays an important role in processes ranging from learning emotional reactions like fears to drug addiction to allergic reactions. For example, seeing someone who makes a lot of trouble for you triggers the body reactions associated with fear or anger before that person does anything. The sight of the person is paired with an upsetting encounter. Soon just seeing that person elicits (triggers) the same body reactions that the upsetting encounter naturally elicits.

Instrumental conditioning refers to learning the consequences of doing something. Many people have heard of the Skinner box, in which a rat learns to press a lever (doing something) when presses are followed by a bit of food (the consequence). The same kind of process works with people. For example, people who work on commission work harder than they might on a salary, because harder work increases their income.

When you have finished this exercise, you should understand the following terms and be able to recognize examples of them:

- Habituation:
- Pavlovian (classical) conditioning
- Conditioned stimulus (CS)
- Unconditioned stimulus (US or UCS)
- Conditioned response or reflex (CR)
- Unconditioned response or reflex (UR or UCR)

Before you go any further doing these exercises on learning, be sure you understand what stimuli and responses are, and how to recognize them. If you want to review these terms, click HERE

Learning is often defined as a relatively permanent change in behavior resulting from experience, which is not the result of species-typical ("instinctive") reactions, maturation, or temporary effects of fatigue, drugs, etc. (paraphrased from Hilgard and Bower, 1966). This definition emphasizes behavioral change as the measure of learning. But like all psychological processes, learning is a process that goes on "inside the head." It must be inferred from changes in behavioral performance.

The University of South Florida maintains a large glossary of terms used in behavior analysis.

Behavior analysis is the term for learning that psychologists who follow B. F. Skinner's general approach use.

Habituation

Habituation is the simplest form of learning. It is learning that a stimulus is not important, because nothing particular happens after it occurs. It is produced simply by presenting a stimulus over and over again without any particular event following it.

When you get a new, unexpected stimulus, it elicits an orienting reflex or reaction (sometimes called the "what is it?" response). The orienting response consists of turning your eyes and head (and attention) toward the stimulus and activating a specific set of brain and body reactions. Habituation occurs when the signal repeats several times without anything specific happening: As it becomes more and more expected, the orienting reaction decreases and finally disappears.
For example, you get a new refrigerator that goes "klunk" every once in a while (it's the ice maker dropping ice into the ice tray). The first few times the "klunk" happens you look over at the refrigerator: this is the orienting reaction. As the sound continues and the refrigerator runs normally, you soon habituate to it. You notice it less and less, until it hardly ever attracts your attention. The three panels in Figures 1-3a, 2-3a, and 3-3a illustrate the development of this habituation.

**Figure 1-3a.** The strong orienting reaction that an unexpected klunk from your new refrigerator produces.

**Figure 2-3a.** The weak reaction and the decreased perception of the klunk after you have heard it a few dozen times and nothing happens.

**Figure 3-3a.** No overt [~external] response and weak perception (if any) of the klunk after many more klunks without anything happening. Habituation is now complete.

Habituation occurs throughout the animal kingdom from simple worms to humans. It follows the same basic rules (Thompson and Spencer, 1966; Groves and Thompson, 1970). For example:

1. The orienting reaction to weak stimuli habituates faster than to strong ones.
2. Habituation occurs fastest if stimuli are presented not too close together and not too far apart in time.
3. Unexpected strong stimuli can make a habituated response reappear temporarily. This process is called *dishabituation*.

**Q1.** Which of the following is an example of habituation?

A. In an experiment, the first time a 2-week-old baby hears the syllable /ba/ from a loudspeaker, she starts sucking on her pacifier. With repeated presentation of /ba/, her sucking declines and stops.

B. A dog stops climbing onto the sofa after she receives shouts of "No!!" and a swat with a rolled up newspaper.

C. Derrick decreases his anxiety before a performance by breathing slowly and deeply and repeating: "my face is soft and smooth."

D. All of the above are examples of habituation.  

**Hint**

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**Pavlovian Conditioning**

*Pavlovian conditioning* (also called *classical conditioning*) is learning an *association* between two stimuli. It is named for I. P. Pavlov (Figure 4-3a), the Russian physiologist who first systematically investigated this form of associative learning. For a short biography of Pavlov, click HERE.

Pavlov noticed this kind of learned association while doing his Nobel Prize-winning research on digestion. In this research he put food in a dog's mouth and measured the flow of
digestive juices, like saliva, that the food elicited (triggered). He noticed that salivation began when the dog saw the food coming, long before it actually got in the mouth. At first he considered this anticipatory salivation a nuisance, interfering with measurements of the digestive process.

Eventually Pavlov recognized the importance of this effect: this salivary response to the sight of food showed learning. The dogs had learned an association between the sight of food and the taste of food in the dog's mouth. Therefore, the process he had observed gave Pavlov a tool to study objectively the processes underlying behavior without having to guess at what the dogs were thinking or what they might know. Pavlov spent the last half of his life investigating the laws that describe how these associations are made and broken.

Q2. What Pavlov observed while studying the physiology of digestion fits the definition of Pavlovian (classical) conditioning because ___.
A. the dogs knew that food was coming and wanted to get ready for it.
B. two stimuli, sight of food and taste of food, are associated.
C. it works on the internal organs where Pavlovian conditioning can occur.
D. it was Pavlov who first studied it systematically.
E. food always triggers salivation in a (hungry) dog.  

Pavlovian conditioning involves learning an association between stimuli.

One of these stimuli is called the **unconditioned stimulus** (often abbreviated as **US** or **UCS**).

"An unconditioned stimulus always elicits an unconditioned response (or **UR**). The **UR** is a specific "built-in" response to that stimulus. The **US**'s effect does not change during conditioning."

- For example, food or a mild acid in the mouth is a **US** because it always elicits (triggers) salivation, even the first time it occurred. The salivation in response to the **US** is the **UR**. You probably recognize from asgn2c that the **US** ➔ **UR** is a **reflex**.

The other stimulus is called the **conditioned stimulus** (often abbreviated as **CS**)

"A conditioned stimulus starts out neutral. By associating it with a **US**, a **CS** becomes able to elicit a new response, which it never elicited before. This new response is called a **conditioned response** (often abbreviated as **CR**). The effect of Conditioned Stimulus changes in the process of conditioning."

- For example, a sound normally has no effect on salivation, but after it precedes food or mild acid in the mouth, it can elicit salivation. Only after it elicits a new response, like the salivation, can a stimulus really be called a conditioned stimulus.

The idea of Pavlovian conditioning was quickly applied to many areas in psychology, because it is an experimental demonstration of a very important idea with a very long history in philosophy: **association of ideas**. Philosophy had long assumed that mental events that were activated together would become associated with each other, so that activating one would also activate the other. Pavlovian conditioning does just this with simple stimuli. The stimuli don't have to be simple. For example, Pavlovian conditioning can be based on the semantic (meaning) content of a word (Corteen & Woods, 1972) as well as its physical sound.

Link to an explanation of how the English terms **conditioned** and **unconditioned** originated. The explanation may help you remember what "conditioned" and "unconditioned" mean. Link to a description of conditioning a pet guinea pig.

Here are some examples of **unconditioned stimuli** and the **unconditioned responses** they elicit:

1. An **air puff to the eye** elicits a **blink**, as illustrated in Figure 5-3a.
2. A **tickle in the nose** elicits a **sneeze**.
3. **Moderate electric shock** elicits a flinch and increased perspiration.
4. The **taste of food** elicits increased **salivation**.
Almost any stimulus can become a CS, as Pavlov showed. A CS starts out as a neutral stimulus, which becomes able to elicit a new response when it is paired with a US. The first time it is presented, it elicits an orienting reaction. After several pairings with a US, the neutral stimulus becomes a CS, when it is able to elicit a response (or reflex) it did not elicit before pairing. The conditioned response (CR) is the response that the CS triggers, which often looks like the US. Figure 6-3a summarizes the way a CR develops.

Here are some examples of conditioned responses (be sure you can recognize the CS, the US, the CR, and the UR):

1. Seeing (not tasting) a dish of double fudge ice cream triggers salivation. This visual signal reliably precedes (precedes) taste of the ice cream, which reliably elicits salivation. The first time you saw a dish of ice cream, it was neutral, because it was unrelated to the taste of the ice cream.

2. A flash of lightning startles many people. This visual signal precedes loud thunder, which reliably elicits the startle reflex.

Using Pavlov’s salivary conditioning as the example, match the process with the part of conditioning it fits best. Hint

1. US    2. CS    3. UR    4. CR    5. either CR or UR
Q3A. salivation in response to bell that precedes tastes of food
Q3B. taste of food in the mouth
Q3C. salivation in response to taste of food in the mouth
Q3D. a bell that precedes taste of food in the mouth
Q3E. salivation

In humans, classical conditioning plays a very important role in emotion. For example, after one or two trips to the dentist, seeing and sitting in the dentist chair are associated the feel of the dental drill, scraper, and probe on your teeth and gums. These unpleasant stimuli reliably trigger body reactions characteristic of pain, like flinching, tensing up, and increased perspiration on the palms of your hands. Seeing and sitting in the dentist chair reliably predicts that the drill, the scraper, and the pick will follow. Your body quickly learns to make similar reactions to the dental chair as it does to the painful sensory stimuli that the dental tools produce.

Match the parts of the dentist chair example with the terms below
1. unconditioned response (UR)    2. unconditioned stimulus (US)
3. conditioned stimulus (CS)    4. conditioned response (CR)
Q4A. flinching and other body reaction to dental drill, scraper, etc. on the teeth
Q4B. the dental drill, scraper, etc., on your teeth
Q4C. seeing the dental chair and dental tools
Q4D. body reactions triggered by seeing the dental chair and dental tools

Different forms of Pavlovian (Classical) Conditioning

The prototypical (~basic) form of Pavlovian conditioning is delayed conditioning. In this procedure, the Conditioned Stimulus (CS) turns on first. After a delay the Unconditioned Stimulus (US) turns on, and these two stimuli usually end together. Thus, the onset of the CS precedes the onset of the US by a delay. Short delays produce the fastest and strongest conditioning. The best delay depends on the kind of CS and US used. The best delay between a tone CS onset and an air puff US onset is about 0.5 seconds. The best delay between a tone CS onset and food US onset is about 2 to 10 seconds. Fear conditioning can be
Eye Blink Conditioning

The Pavlovian conditioned eye blink reflex has received much attention in the past several years (Steinmetz, 1999). Figure 7-3a summarizes the development of simple delayed eye blink conditioning.

The procedure is easy to do on humans as well as animals, and it develops slowly enough that the development of the CR can be studied in detail. The conditioning very similar across species. Therefore, it is easy to compare data from humans and other animals. Domestic rabbits are the animal for choice (Gormezano, 1963), because they adapt very well to the restraint that make eye blink conditioning easy to train and measure. [They adapt to restraint well because they naturally freeze a lot]. Restraint also helps recording activity from neurons in the brain during conditioning (Thompson et al., 1987), which has become a powerful tool for understanding the brain processes on which Pavlovian conditioning is based.

Eyelid conditioning in humans turns is a useful tool for analyzing deficits in brain disorders. For example, people with autism show abnormal effects of varying the time interval between CS and US. This abnormality probably reflects subtle abnormalities in the function of the hippocampus of the cerebral hemispheres. (Sears et al., 1994)

In a typical eye blink experiment, participants wear a frame for eyeglasses on which are mounted the air puff nozzle and a device to measure the blink. At intervals averaging about 20 seconds, a tone comes on, and about half a second later the nozzle delivers a puff of air.

Before being paired with the air puff, the tone never triggered an eye blink, as illustrated in Figure 5-3a. In less than 100 tone -- puff pairings (under some conditions as few as 2 to 4), the eye blinks just before the air puff turns on, showing that this eye blink was a response to the tone. The development of the eye blink conditioned response is illustrated in Figure 7-3a.

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**Eye Blink Conditioning:**

Figure 7-3a. Development of eye blink conditioned response by a tone pre-ceding an air puff aimed at the eye.

On **Trial 1**, the tone (CS) does not elicit any movement of the eyelid, because it has never been paired with the air puff.

On **Trial 10**, the tone elicits the beginnings of an eye blink conditioned response. Because it comes before the air puff, this small movement of the eyelid must be a conditioned response.

On **Trial 50**, the tone elicits a large, almost complete eye blink conditioned response before the air puff comes on.

On **Trial 51**, only the tone comes on. This is a test trial to see how effective the tone alone is. It elicits a strong conditioned response (the eye closes almost completely) in the absence of an air puff. Unconditioned stimulus.
The conditioned eye blink is an automatic non-conscious reaction to the tone, not a voluntary response to prevent the air puff from reaching the eye. It is too fast; voluntary eye blinks are considerably slower. In fact, if volunteers are asked to blink as soon as they hear the tone, they do not develop the conditioned eye blink. Preparing to make the slower voluntary response appears to prevent the automatic reflex response.

Match each of the following with its name in Pavlovian conditioning.  

<table>
<thead>
<tr>
<th>Q5A. eye blink to air puff</th>
<th>Q5B. eye blink to tone</th>
<th>Q5C. air puff</th>
<th>Q5D. tone</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CS</td>
<td>2. CR</td>
<td>3. UR</td>
<td>4. US</td>
</tr>
</tbody>
</table>

Eye blink conditioning does not require complicated expensive apparatus. In my first teaching assignment as a graduate student, I helped build a couple dozen eye blink conditioning devices for use in an introductory psychology lab. It produced a hum CS that turned on about 1/2 second before an air puff US aimed at the eye was delivered. People in the class quickly developed conditioned eye blinks, as measured by blinks on occasional trials when the hum CS occurred without the following air puff US.

The pump that produced the air puff made a loud "whack," which occurred simultaneously with the puff. One person in the class asked which was really the Conditioned Stimulus: the hum that came on 1/2 second before the puff or the much louder "whack" that came on simultaneously with the air puff. The instructor and I turned off the hum, and the student retested his partner. The next question asks you what the student found.

Q6. Based on the information provided in the preceding paragraphs, what do you think the student found when he retested his partner using only the loud "whack" that occurred simultaneously with the air puff?  

A. conditioned eye blink about equal to the one produced with hum CS  
B. stronger than normal conditioned eye blink because of louder CS  
C. a response opposite to CR to hum, because whack signaled the end of the puff  

D. no conditioned eye blink

Click HERE for a summary of the different forms of Pavlovian conditioning, (Click on the links in the document)
Once a CR has been established, it can be weakened and suppressed by a process called **extinction**. To extinguish a CR, you **present the CS alone, without the Unconditioned Stimulus**. For example, consider the Pavlovian eye blink CR, described at the end of asgn3a. The tone was established as a CS. It reliably elicited an anticipatory eye blink before the air puff US is turned on.

The CR can be suppressed by the process of **extinction**. To extinguish the eye blinks, the tone CS is presented repeatedly without the air puff US following. With repeated presentation on the tone alone, the CR eye blinks to it become weaker and less probable, until they disappear almost entirely (when tested again, the US remains unchanged).

**Q1.** A CR can be weakened and eliminated by
A. presenting the CS without following it with the CR
B. not presenting the CS under any condition
C. presenting the CS without following it with the US
D. presenting the US without following it with the CS

**Hint**
Disinhbitition refers to the reappearance of a CR during extinction when a CS presentation is preceded by some unexpected distraction. For example, toward the end of the extinction process when the CR is weak and irregular, an unexpected stimulus, like an unexpected noise, will increase responding to the tone. The unexpected noise temporarily reinstates the CR.

**Extinction is an active inhibitory process, not forgetting or unlearning.** Three phenomena show this: spontaneous recovery, disinhibition, and rate of relearning.

- **Spontaneous recovery** refers to the reappearance of a CR without further training when tested sometime after it was extinguished. In the eye blink CR, the volunteer is retested two days after the eye blink CR was extinguished. She blinks in response to the first CS tone, showing that the learned association between CS and US was still present after extinction, even though it no longer showed up in performance at the end of extinction.

**Q2.** Extinction is not forgetting because
A. a CR is relearned faster than it was first learned
B. distraction makes a CR reappear during extinction
C. an extinguished CR reappears when tested the first time a few days later
D. all of the above are correct
E. none of the above. Extinction is forgetting because the CR is lost

**Conditioning occurs in people all the time.** It is easiest to see for emotional reactions. For example, a volunteer wearing a space suit hurtles down a rail in an "impact sled," which smashes against a barrier. (This tested the effects of different kinds of impact on the space suit.) During the 40-second countdown an alarm horn sounds. Its sound predicts smashing into the barrier. Smashing into the barrier strongly activates the sympathetic nervous system. Years after the tests were over, this volunteer experiences strong body reactions which the sympathetic nervous system produces, when he heard a sound like that alarm horn (Barker, 1997, p. 127).

**Q3.** Match the following from the preceding example to the parts of Pavlovian conditioning they fit best.

1. US (Unconditioned Stimulus)
2. CS (Conditioned Stimulus)
3. UR (Unconditioned Response)
4. CR (Conditioned Response)

**Q3A.** body reactions to a sound like the alarm horn’s
**Q3B.** body reactions to riding the impact sled and hitting the barrier
**Q3C.** a sound like the alarm horn’s
**Q3D.** riding the impact sled and hitting the barrier

To summarize the most important points:
- An **US elicits (triggers) a specific UR unconditionally**, regardless of past history or experience.
- A **CS (CS) becomes able to elicit a new response it couldn’t trigger before (the CR) by predicting a US**. Its ability to elicit the new response is conditional on (depends on) predicting that US.
- A **CS loses the ability to trigger the new response if it is repeatedly presented alone**, without the US; this is called extinction.
Extinction is not the same as "forgetting" because retesting the CR during and after extinction shows that the CR has not been forgotten.

- The CR shows spontaneous recovery: it reappears after some time has passed without further training.
- Distraction during extinction reinstates the CR on the following trial.
- The CR is relearned much quicker after extinction than it was originally learned.

Match the following terms with the examples they fit best:

1. stimulus 2. response 3. extinction 4. spontaneous recovery

Q4A. this happens when the tone no longer predicts air puff directed at the eye.
Q4B. the tone; the air puff directed at the eye
Q4C. blinking to the tone
Q4D. this happens when the volunteer is retested with the tone a day after the process in A is complete

Pavlovian conditioning is often tested with discrete (~separate, specific) reflexes, like the salivary that Pavlov used. The eye blink reflex in response to an air puff, described above, is particularly useful because it is fairly easy to measure, it is fairly similar in many different animal species, including humans, and it develops slowly enough that the development of the CR can be studied in detail. Eyelid conditioning in humans turns out to be a useful tool for analyzing deficits in patient populations. For example, people with autism show abnormal effects of varying the time interval between CS and US. This abnormality probably reflects subtle abnormalities in the function of the hippocampus of the cerebral hemispheres. (Sears et al., 1994)

Complex behavioral reactions can also be controlled by steps that fit the Pavlovian conditioning paradigm: pairing two stimuli, a CS and a US, regardless of the subject's actions. "Auto-shaping" (a better name is sign tracking) is a very well-studied example of Pavlovian conditioning acting on a more complex behavior. (The name refers to its apparent similarity to a process called shaping, described in exercise asgn3e on instrumental conditioning.)

In the basic auto-shaping experiment, a hungry animal, like a pigeon, sees a key light up for several seconds before food appears, regardless of what it does. It soon begins to peck at the lighted key as if it were food. The lighted key serves as a CS; initially it elicits (triggers) only an orienting reaction. The appearance of food acts as a US; it reliably elicits eating. The two stimuli are presented regardless of what the bird does. Figure 1-3b summarizes what happens on the first few presentations of the CS followed by the US.

The same process occurs when a rod inserted into a thirsty rat's cage predicts access to water. The rat starts licking the predictive rod as if it were the tube from which it got water. Auto-shaping also occurs in humans. (Pithers, 1985).

Q5. A child starts to pat a panel when it lights up, if it signals that a marble is coming. (She can exchange marbles for a prize.) Her patting the lighted panel (see preceding paragraphs) fits the paradigm (rules) for Pavlovian (classical) conditioning if

A. the marble rewards patting the light  
B. you tell the child to pat the lighted panel to earn a marble
C. lighting the panel reliably predicts delivery of marble
D. the two events (light, marble) are paired regardless of what the child does
E. A and B are both correct  
F. C and D are both correct
Brain Changes in Learning

When learning takes place, some change must take place at synapses in the brain circuits involved in that learning. To understand these changes, the brain circuits involved in learning a particular CR must be identified, the location(s) of synaptic changes must be found, and the processes that produce the changes must be described.

Many model systems have been studied. The eye blink Pavlovian conditioned reflex has become an important model system for several reasons:

! It is basically the same in all mammals that have been studied.
! It is easy to study in humans, in rabbits, and in other animals, as well
! It is only slightly unpleasant, so humans tolerate it well, and rabbits adapt well to the restraint needed to measure it, because they hold still naturally.
! The full eye blink CR develops in as few as 100 trials, which allows the researcher to follow the learning in detail within one or a few sessions.
! It shows abnormalities in behavioral disorders, such as autism, which provides a tool for understanding the brain abnormalities associated with the behavioral disorders.

To study how learning occurs in the brain, you must know where it occurs. Karl Lashley thought that "engrams" (his name of the hypothetical brain changes in learning) were distributed widely throughout the cerebral cortex. He tested rats on their ability to respond selectively to the visual pattern that was associated with food following damage to different parts of the cortex. He found that the amount of damage was more important than the exact location and concluded that an engram is not located in one specific place. This conclusion reflects the particular kind of behavioral test Lashley used and the brain areas he chose to target. More recent research has shown that simple Pavlovian CRs depend on a crucial place in the complex network that normally supports them.

For eye blink conditioning in rabbits, that crucial place is in a cluster of neurons deep inside the cerebellum called the interpositus nucleus (Steinmetz, 1998). Several lines of evidence show this, including:

! Selective lesions (~damage) of this nucleus abolish the conditioned eye blink and prevent (re)learning. The blink to the US remains intact, showing that the eye blink response can still occur. Reversible "lesions" reduced by temporarily cooling the nucleus interpositus block

! the CR, but when it warms up again, conditioning progresses normally.
! Damage to the cerebellum that spares the interpositus nucleus and its connections spares the conditioned eye blink and permits learning it.
! Measurement of the activity of neurons in the interpositus during learning shows changes in activity of neurons that is closely tied to the development of the conditioned reflex.

For conditioned emotional reactions the amygdala in the limbic system of the temporal lobe appears essential. Link to more about the brain processes in eye blink conditioning.

Other model systems that have been studied include:

! Invertebrates (without backbones), which have much simpler nervous systems, made of thousands of neurons rather than the 100 million+ neurons of even simple vertebrates. Two sea snails, Aplysia and Hermissenda, have received a lot of attention, and detailed information about the biochemistry of synaptic change is available. The changes depend on changing the sensitivity of the dendrites to depolarization and hyperpolarization.

Simplified model systems within the mammalian nervous system, which can change sensitivity after some sort of training. A process called long term potentiation (LTP) has been studied extensively. Brief, intense stimulation of certain brain pathways makes the response to subsequent stimulation much stronger, because the sensitivity of the synapses involved has been increased. Figure 2-3b shows and example of LTP.
Many complex forms of learning have also been studied, ranging from rats learning mazes to monkeys making complex choices. For example:

As a rat learns a maze, single neurons in the hippocampus (the part of the temporal lobe that is essential for "memory") begin to respond when the rat is in a particular place in the maze (see asgn3l).

As a monkey makes complex decisions based on memory, neurons in the cortex of the frontal lobes show selective changes associated with the correct response.

Q6. Experiments show that the nucleus interpositus is crucial for eye blink conditioning and that the amygdala is crucial for fear conditioning. These experiment show ___.

A. what learning really is  
B. where in the brain, synaptic changes occur in learning  
C. how synapses change during learning  
D. that the brain does not change during learning because only brain damage shows what learning is

Discrimination and Generalization

Discrimination occurs when an individual responds differently to two (or more) different stimuli. This is the operational definition of discrimination. To respond differently to the stimuli, you must be able to tell them apart somehow. That is discriminating between them. Discrimination is a useful tool for understanding how learning works and for studying many other processes. It's the only way to study perceptual abilities of nonverbal creatures, like babies, monkeys, pigeons, etc. It is also used as a tool to study a variety of normal and abnormal behavioral processes in humans.

A discrimination is established by having a stimulus predict a US, and its absence predict no US. The following explanation uses a form of Pavlovian conditioning called autoshaping or sign tracking.

The bird is put in a box, called a Skinner box, for B. F. Skinner who designed and used it first. The basic Skinner box has three devices: one to deliver stimuli, one to measure a response, and one to deliver a reinforcer. For pigeons, visual stimuli are often projected onto a panel on the wall of the box. This panel also detects pecks the bird directs at it. The reinforcer is often food delivered in a retractable tray. In autoshaping, a stimulus, called S+ (or discriminative stimulus), predicts a reinforcing event. After several of these pairing, the bird starts to respond to the S+ as if it were the unconditioned stimulus.
Figure 1-3c shows the initial conditions for using autoshaping to condition a hungry pigeon. [Click HERE to review definitions and abbreviations for basic terms in Pavlovian conditioning] In Figure 1-3c, the pigeon sees a panel light up for 8 seconds, after which a tray with grain in it appears for 8 seconds. After several trials, the bird begins to peck at the panel as if it were food. After several red light - food pairings, the bird starts pecking the red-lit panel. As illustrated in Figure 2-3c, after 100 pairings it always pecks the panel when it is red and never pecks when it is unlit. Therefore, the bird discriminates between the red-lit and the unlit panel. The red-lit panel is now a CS+; the unlit panel is a CS-.

Figure 1-3c. Establishing a discrimination between a red light and no light. Trial 1, the first time that the panel is lit with red light and is followed by inserting a food tray. The bird may respond to the red panel by orienting to it (asgn3a).

Discrimination Training: Trial 1

Figure 2-3c. Establishing a discrimination between a panel lit with red light and an unlit panel. Trial 100.

Discrimination Training: Trial 100

Figure 3-3c. Generalization from CS+ (red-lit panel) to other colors of light.

Generalization can be defined as responding to related stimuli in the same way: If a stimulus has been established as a CS+, generalization can be tested by substituting a new stimulus for the CS. To the extent that the new stimulus also produces the CR, it produces generalization. The amount of generalization can be used as a measure of similarity between two stimuli.

In the example of the pigeon trained to respond when a panel is lit with red light, the bird can be tested with other colors of light. The bird responds almost as much to these colors of light as it does to the red CS+. The bird has generalized to lights of different colors. Figure 3-3c illustrates the generalization test.

Q1. A video shows a pigeon pecking on a panel when the word "peck" appears on it and turning around when the word "turn" appears. This is best(most specifically) described as
A. reading    B. Pavlovian conditioning    C. discrimination    D. learning    E. performance

In the example of the pigeon trained to respond when a panel is lit with red light, the bird can be tested with other colors of light. The bird responds almost as much to these colors of light as it does to the red CS+. The bird has generalized to lights of different colors. Figure 3-3c illustrates the generalization test.
Q2. Which of the following is an example of generalization?
A. a pigeon is trained to peck at a key when the word "peck" appears on it
B. after having been frightened when Rover the dog licks his face, Peter is afraid of other dogs
C. a pigeon is trained to peck at a key when the word "peck" appears and to turn around when the word "turn" appears
D. a baby stops sucking on her pacifier after hearing /ba/ over and over again
E. B and D are both correct

But perhaps the pigeon in the example responded to the new color of light because it is color blind and cannot tell the difference between the different lights. This alternative explanation of the bird's behavior can be tested by trying to establish a **discrimination** between the red CS+ and another color, say the blue light. The pigeon can be tested for its ability to discriminate colors by using two kinds of trials:

1. trials with the red CS+ followed by the food US, as during training
2. trials with the blue light followed by nothing

The bird continues to respond with pecks to the red-lit panel but slow down and eventually stop responding to the blue.

Q3. The process that decreased and stopped responding when the blue light was on the key is called __.
A. autoshaping   B. habituation  C. Pavlovian (classical) conditioning  D. extinction  E. A and B are both correct

Definitions for A,   Definitions for B,  Definitions for C,  Definitions for D

When the bird responds to the color that predicts food (the red) but not to the other (the blue), it has learned to discriminate between these two colors. Discrimination training of this kind shows that pigeons can tell the difference between very small changes in the color of light. They can discriminate color at least as well as humans can. Figure 4-3c illustrates a pigeon's behavior once it has been trained with red light predicting food and blue light predicting no food.

Generalization and discrimination tests are excellent methods for testing sensory capacities. Such tests have shown that many species of birds and fishes have very good color vision, whereas many mammals either are completely color-blind or resemble humans with red-green color blindness. DeVAlois (1966) used it to show that old world monkeys discriminate colors in the same way that humans do (see asgn2m).

Q4. Which of the following is an example of discrimination?
A. a pigeon is trained to peck at a key when the word "peck" appear on it
B. after having been frightened when Rover the dog licks his face, Peter is afraid of other dogs
C. a pigeon is trained to peck at a key when shows "peck" and to turn around when shows "turn."
D. a baby stops sucking on her pacifier after hearing /ba/ over and over again
E. a baby resumes sucking when /ba/ changes to /pa/ (see D)       F. C & E are both correct

**Necessary and Sufficient Conditions for Pavlovian (Classical) Conditioning**

Pavlov investigated several basic questions about classical conditioning. He tested many different stimuli -- sounds, lights, touches, even electric shock -- to find out what kind could serve as a CS. Under proper conditions all the stimuli he tested could become a CS for the salivary conditioned reflex (CR).

He also showed that **contiguity** (closeness, especially in time, but also in space) **between CS**
and US produced the quickest and strongest conditioning. The best time interval between the start of the CS and the start of the US is somewhere between about 1/4 second and 2 seconds, depending on the CR. Based on these facts, Pavlov concluded that any stimulus could serve as CS for any US as long as they were turned on close together in time.

Recent research shows that contiguity produces faster and stronger conditioning, but is not necessary or sufficient (needed or enough) to establish many kinds of CRs. In addition, certain kinds of CSs have a privileged relation with specific kinds of USs. They work much better together than do other kinds. For example, we are much more likely to be hurt by electric shocks from a defective electric plug than by a spider, yet many people who are not afraid of electric plugs do fear spiders.

Q5. In classical conditioning the CS turns on just before the US turns on. This contiguity (closeness in time) between the onset of the CS and of the US __.

A. is required for classical conditioning  
B. is the only thing needed for classical conditioning to occur  
C. makes learning occur fast  
D. all of the above are correct

Taste aversion learning is the most extreme example of learning an association when two stimuli are not close together in time. It is also the best example of a privileged association between two specific kinds of stimuli. Humans and animals avoid a flavor when that flavor is followed even hours later by feeling sick to the stomach. This association is often established in a single trial. For this association to develop, the predictive stimulus must be flavor. Painful shock does not work. Conversely, flavor is not a very good CS for learning to avoid shock. This illustrates the idea that certain kinds of stimuli are more easily associated with each other.

Q6. Ginnie gets sick to her stomach after eating ham salad at a picnic. At the same picnic she gets a painful sunburn from playing softball. In the future she is most likely to

A. associate playing softball with feeling sick to her stomach  
B. avoid the flavor of ham salad  
C. associate sunburn with feeling sick to her stomach  
D. avoid eating at picnics  
E. avoid getting sunburned

Contiguity between the CS and US is not enough to establish a CR. A CS and US can be presented together, but conditioning is weak or absent if the CS also occurs alone, without the US following it. The more frequently a CS occurs alone without a US, the weaker the Pavlovian conditioning is.

This fact indicates that the predictive relation between CS and US is the critical factor for learning to occur. For conditioning to be strong, the CS must have high validity for predicting the US: The CS must consistently predict the US. Every time the CS occurs it must be followed by the US.

If additional CSs are given without being followed by a US, conditioning is weakened. The following examples illustrate predictive validity. If a 10-second tone predicts food on every one of 20 trials, a hungry rat quickly becomes active and approaches the food tray as soon as the tone sounds. But if a 10-second tone predicts food on 20 trials but on another 20 trials the tone comes on alone, a hungry rat does not respond much to the tone. Or, suppose the doorbell on your house develops a defect so it rings occasionally when on one it at the door. You are likely to become slower to go to the door.

Q7. [Mark EACH item True (T) or False (F)] For conditioning to occur, the CS must

A. be turned on as long as the US lasts  
B. accurately predict that the US will follow  
C. have high predictive validity  
D. occur more often than the US

Blocking is another situation in which a stimulus that is closely associated with an US fails to become a CS. Blocking refers to the lack of conditioning to a new stimulus, Stimulus 2 (S2), that is added to an already established CS+.

The existing CS+ blocks the association of the new S2 with the US, perhaps because the existing CS+ prevents attending to the new S2 or because the new S2 adds no predictive validity to the CS. Blocking, like predictive validity, shows that simple contiguity (closeness in time) between CS and US is not enough to establish Pavlovian conditioning.
Q8. For 50 trials, a light is flashed simultaneously with (at the same time as) a well-established tone CS. When the light is presented alone it
A. prevents the CR from occurring because it blocks the presentation of the established CS
B. produces little or no CR because the established CS blocked its association to the US
C. produces a strong CR because it was contiguous with the US
D. produces a strong CR because it has high predictive validity from predicting the CS