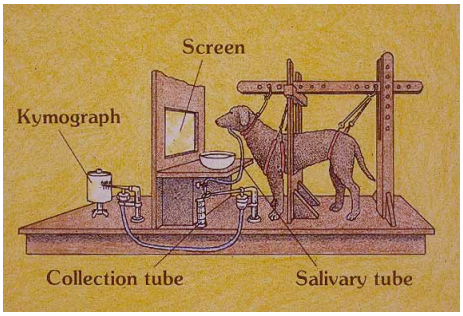
Classical Conditioning Overview

Classical conditioning was first identified and developed by a Russian physiologist, Ivan Pavlov. The phenomenon of classical conditioning is widely considered to be the most fundamental form of learning. Even before Pavlov

identified the process of conditioning, his work was monumental. In fact, Pavlov was awarded the Nobel Prize in Physiology and Medicine for his research on the digestive system of dogs. To pursue his digestion research, Pavlov developed a procedure for surgically implanting a tube, called a fistula, into living animals. This allowed him to collect and measure digestive secretions, such as those released in the stomach or the mouth. This was a first, because up until Pavlov's innovation, almost everything that was known about physiological processes was obtained from studies involving acute (temporary or sacrificed animals) as opposed to chronic preparations (long-term and in living animals).

Pavlov was interested especially in the mechanisms of reflexive secretions when food was placed into the mouth and as it passed through the other parts of the digestive system, including the stomach. For example, Pavlov or one of his assistants would place meat into the mouth of a dog and then measure the amount of saliva that passed through a salivary fistula implanted for collecting saliva in a test tube pasted onto the outside of a dog's cheek

With the aid of his fistula preparations Pavlov made a very surprising



discovery. He noticed that his dogs began to salivate upon merely seeing Pavlov's lab assistant entering the room or getting out the food pans, even before any food was presented! Pavlov thought it peculiar that a reflex such as salivation should be present with no apparent stimulus, such as food, to trigger it. Pavlov discontinued his digestion research and focused exclusively on this new and curious phenomenon he originally called ''psychic reflexes" (Pavlov, 1927/1960).

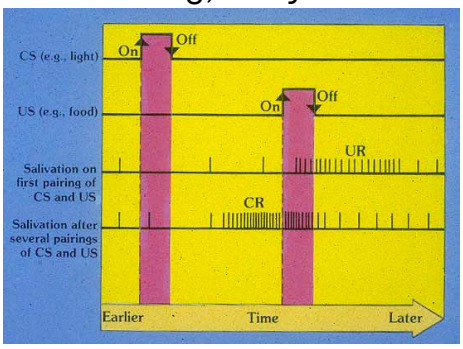
Through further investigation Pavlov discovered that his psychic reflexes developed through a process he could control and manipulate. He called this process ''conditioning'' because it defined the conditions under which reflexes would occur to previously ineffective, or ''reflex-neutral'' stimuli. In this process Pavlov began to substitute highly specific manipulated stimuli as alternatives to the less controlled entry of his lab assistants or presentations of empty food pans.

Pavlov turned to the use of such specific and controllable stimuli as the sound or even the specific rate, of a metronome's ticking. In Pavlov's classic experiments, from which the process gets its name of Pavlovian conditioning, or classical conditioning, a stimulus is first tested to assure it is ''neutral,'' in that it does not elicit salivation. Then that neutral stimulus is presented along with a stimulus, such as food, that is known to elicit salivation. After a few repetitions of this temporal pairing of the two (neutral and eliciting) stimuli, the previously neutral stimulus is found to be no longer neutral, but now will elicit salivation when presented by itself (Pavlov, 1927/1960).

Early philosophers, such as Aristotle, had emphasized the importance of temporal associations for acquiring or learning new actions but a fully developed Associationism philosophy proposing that associations were the form of virtually all learning came in the 17th and 18th century's philosophical movement known as British Associationism. This movement largely began with John Locke (1632-1704) and eventually included other British philosophers such as David Hartley and James Mill. The Associationists suggested a set of three principles that they felt established the foundation for the formation of associations in human thought. The Principle of Contiguity stipulated that associations were formed between events that occurred together in time. The Principle of Frequency stated that the more often two events occurred together, the more strongly associated they would be with one another. And finally, the Principle of Intensity referred to the strength of the feelings that accompanied the association (Locke, 1690/1959).

But it was Pavlov who was one of the first to study associations objectively and empirically (scientifically) and to give associations an importance in the development of new physiological and emotional reactions as well as mental activities. Classical conditioning is based on reflexive responses and the associations between stimuli that do and do not naturally elicit those reflexive responses. Pavlov investigated many details of how neutral and reflex-eliciting stimuli can be variously paired in time, and thus defined several alternative procedures that are variations on classical conditioning.

These procedural variations on classical conditioning include simultaneous conditioning, delayed conditioning, backward conditioning, trace conditioning, temporal conditioning, and extinction, as well as differential conditioning and its related phenomenon, stimulus discrimination. All of these procedures utilize classical conditioning variables, which include an unconditional stimulus (UCS) such as food, and a neutral stimulus (NS) such as a ticking metronome that doesn't elicit salivation. As Pavlov discovered, when paired with a UCS like food this neutral stimulus



gradually becomes an effective elicitor for salivation, and thus can then be called a conditional stimulus (CS). The effects of such temporal pairing are seen in the development of a conditional response (CR), such as salivation when the metronome alone is ticking. The original salivation to food (UCS) is reflexive and thus requires no pre-conditions to establish its elicitation function. Thus Pavlov called this reflexive form of salivation the unconditional response (UCR) (Pavlov, 1927/1960).

Pavlov's classical conditioning has many applications, including the development of emotions and consumer attitudes through temporal parings of brand names or objects, like cars, with evocative, sexually arousing, or fun-related stimuli in advertising (Watson, 1936). Classical conditioning also has applications in therapeutic environments. For example, classical conditioning procedures are fundamental in our understanding and treatment of phobias. Research on conditioned emotional responses has led to a better understanding of how phobias and addictions form (Watson & Rayner, 1920). Working from this knowledge psychologists have also been able to develop therapies called systematic desensitization, aversion therapy, and counter conditioning, to reduce or eliminate these emotional problems (Wolpe, 1958). Farmers use principles of conditioned taste aversion (which stem from classical conditioning procedures) in order to keep predators from attacking their flocks. This is more ecologically sound and humane form of predator control than extermination of the predator population (Gustavson, 1974). Classical conditioning has even been applied in the field of medicine where immune responses are conditioned so that a patient takes less medication with the same immune boosting effects (Buske-Kirschbaum, 1994).

Variables in Classical Conditioning

There are several variables involved in classical conditioning and it is important to understand how they are labeled and used in the conditioning process. Pavlov was the first to identify and label these variables, and his terms are still widely used still. The foremost independent variable is the unconditional stimulus (UCS), such as food. Its associated dependent variable is the response it elicits, called the unconditional response (UCR). In Pavlov's typical research this UCR was salivation. A second independent variable, as it exists prior to conditioning, is called the neutral stimulus (NS), but when paired successive times with the presentation of the UCS, this NS gradually acquires the function of also eliciting a response similar to the UCR, and in this state the stimulus is called the conditional stimulus (CS). An example of a NS evolving into a CS is when a ticking metronome elicits no salivation prior to

conditioning (thus defining the stimulus as ''neutral,'' or a NS), but eventually it comes to elicit salivation (thus becoming a CS) because it has been paired in time with food (the UCS). Such stimulus pairing procedures eventually cause the dependent variable (salivation) to appear as a conditioned response (CR) even if only the CS (metronome) is presented by itself.

The unconditional stimulus (UCS) is any stimulus that naturally elicits or brings about a specific unconditional response, thus making it reflexive in nature. In Pavlov's research the UCS was typically food, and it naturally brings about the reflexive response of salivation. As another example, a loud sound could be an UCS for a startle reaction as the UCR. The UCS qualifies as an independent variable because Pavlov manipulated its presence in all of his experiments, including in his physiological research of digestive reflexes that predated his work on conditioning.

You may have already noticed that when we describe the effect of the unconditional stimulus (UCS), and eventually the conditional stimulus as well, we use the term ''elicit.'' To elicit a response means to reliably cause that response to occur. A reflexive behavior (UCR) is described as being elicited because it reliably occurs in response to a particular stimulus (UCS). Without this stimulus the response rarely occurs, thus making the UCS necessray and sufficient to produce the response. Thus, for example, you can't startle someone without such a stimulus and try as you may, you cannot bring about the startle response in yourself except by sheer accident (the stimulus is otherwise not unexpected). Because of this, we say that a strong, unexpected stimulus elicits, or causes, the startle response, and this relationship between stimulus and response defines what is meant by the word reflex. In Pavlov's work in classical conditioning, meat elicits salivation.

The amazing finding was, however, that after repeated parings of a metronome. bell, or light NS with the presentation of meat, the NS became a CS and thus began to elicit salivation as well. Thus we say there is a conditional reflex that has been established through the stimlus pairing, or ''conditioning,'' procedure. We learn to react as if reflexively to stimuli that usually do not elicit a reflexive response if the stimuli are contiguous with a stimulus that does elicit a reflexive response. That is the essence of Pavlov's conditioning discovery.

Use of an UCS automatically elicits the dependent variable in classical conditioning: the unconditioned response (UCR). The unconditioned response is the generic label for the reflexive behavior elicited by the unconditioned stimulus (UCS). In much of Pavlov's conditioning research, the UCR was salivation. However, he also investigated many other forms of reflex relationships beyond food eliciting salivation. Nevertheless, salivation is his most typical response, and may be described as a dependent variable because Pavlov measured salivation using his

fistula preparation and because salivary flow is dependent upon the presence of the independent variable, food.

The neutral stimulus is also a very important variable in classical conditioning. A neutral stimulus is any stimulus that does not elicit the reflexive response, or UCR. A metronome does not normally elicit salivation, so in Pavlov's experiments the metronome begins as a neutral stimulus. A metronome could be an UCS for ear pricking behavior, however. So a stimulus is not always an absolutely neutral stimulus, it is only neutral with respect to the response under investigation as the dependent variable, such as not eliciting salivation. So it depends on what reflexive behaviors you are focusing on as to whether a stimulus may be an UCS or a NS.

After appropriate classical conditioning procedures, or CS-UCS pairings, have occurred several times, the neutral stimulus gradually comes to elicit a response that typically resembles the UCR. In this case it is no longer neutral. Thus Pavlov described it as a conditional stimulus (CS) because his experimental conditions had created a new elicitational function for this previously neutral stimulus. A metronome's ticking that elicits salivation after conditioning is a conditional stimulus (CS) for the conditional salivary reflex (CR) , since salivation will occur even if the food isn't presented.

The CS is a classical conditioning label that applies only after conditioning procedures have been used for a sufficient number of trials required to obtain a conditional reaction to that CS. A metronome that is ticking and not eliciting salivation is a neutral stimulus. A metronome that is ticking and subsequently elicits salivation after being paired with a UCS for a few trials is now a conditioned stimulus. It is important to keep in mind as you read about classical conditioning procedures that while the metronome is the same physical stimulus both before and after conditioning, psychologically it is neutral before conditioning and becomes conditional only after conditioning trials are experienced. As such, such such a stimlus represents two separate functions for the same variable at different stages of the experiment.

Once a CS has the power to bring about a resemblance of the UCR, this new response is labeled a conditional response (CR). Salivation in response to a metronome ticking is a CR, because prior to conditioning, salivation is not elicited by a metronome ticking. As in the case of the CS, it is important to remember that while salivation may appear to be the same response before and after conditioning, it is an unconditioned response before conditioning and a conditioned response after, depending on which type of stimulus elicits it. Hence, the same apparent response serves as two different functional variables and how it is labeled depends upon whether classical conditioning procedures have occurred or not and upon which stimulus (CS or UCS) is eliciting it(Pavlov, 1927/1960).

Later research actually has demonstrated that the CR only appears to resemble the UCR, but even in the case of salivation, the chemical compositions may not be exactly the same for the two forms of saliva. And when the reflexive reaction of the cardiovascular (heart) system to a startling noise is measured, the UCR is a sharp acceleration in heart rate while the CR is actually a deceleration in heart rate! So in this case the CR appears to function more like an ''anticipatory reaction'' than the actual reflexive response we call the UCR. It is on this as well as other basis that Rescorla, a modern researcher specializing in classical conditioning procedures, has interpreted the critical aspects of Pavlov's procedures to be the existence of an actual contingency (if-then) relationship between CS and UCS rather than simple associative contiguity in time. We'll revisit this stimulus-contingency interpretation in a subsequent section on ecological perspectives in learning.

Finally, one of the most important independent variables in classical conditioning is the time element used to define how the two stimuli occur together. That is the NS/CS occurs together with the UCS in time. But the actual timing has been manipulated and explored for its own effects on the conditioning process. Manipulaton of the time variable becomes complex, in that there are many variations of how the two stimuli can appear and still be contiguous, or occurring at, or nearly at, the same time. These variations of timing define alternative classical conditioning procedures, and it is to these various procedures and the role of time in their definitions that we now turn.

Time-Based Procedures in Classical Conditioning

The defining procedure for classical conditioning is that of establishing an if-then, or contingency, relationship between two stimuli which are used as independent variables in the conditioning process. Critical to this definition is the fact that one stimulus at the beginning of the procedure is neutral in function (NS/CS). That is, it does not elicit the reflexive response being investigated for conditioning. The other stimulus, both from the beginning and throughout the procedure, is an effective elicitor (UCS) for the reflexive response (UCR) being conditioned. In his initial research, Pavlov identified such a procedure as one which involves the temporal pairing of the neutral stimulus with the UCS. Through repetitions of these pairings multiple times (each time constituting a ''trial'') the neutral stimulus comes to elicit the target reflexive response and is thus transformed functionally into a conditional stimulus (CS). This usually takes repeated trials, as the neutral stimulus rarely elicits a CR after only one pairing.

Pavlov eventually explored many different variations for presenting the stimuli involved in his original classical conditioning procedures. These variations all are based on how time varies in the presentation of the two stimuli, and they include delayed conditioning, simultaneous conditioning, backward conditioning, trace conditioning, temporal conditioning, and extinction. Pavlov also explored procedures which did not rely on temporal variations between the CS and UCS. These include stimulus generalization and discrimination as well as related effects--all of which will be described in a separate section because they don't use time as the critical defining procedural variable.

Delayed conditioning was actually Pavlov's initial procedure, which was fortunate based on subsequent findings that most other procedures are not very effective, if at all, for developing a conditional response. In the delayed procedure, Pavlov actually started the ticking of his metronome, the CS, a bit before he presented the food (UCS). The metronome continued to tick from just before the presentation of food and continued ticking throughout the dog's eating. The critical aspect was the slight delay between first presenting the metronome and the subsequent presentation of the food. It is from this temporal delay that the delayed conditioning procedure derives its name.

Eventually many variations of temporal delay between presenting the NS/CS and the UCS, technically called the inter-stimulus interval (ISI), were investigated and an optimum ISI (or time between the two stimuli) was discovered. Pavlov found that conditioning is most effective if the UCS is presented .5 to 1 second after the presentation of the neutral stimulus (NS). Pavlov found that when more time exists between the two stimuli conditioning is weak, if present at all. Subsequent research has found this rule to vary depending upon what response system is investigated as the dependent variable (conditional and unconditional response). Pavlov was measuring salivation, and his rule of .5 to 1 second optimal delay is true for that form of response (Pavlov, 1927/1960).

But if heart rate is being classically conditioned, the .5 to 1 second optimal ISI changes and an ISI of up to 5 seconds or even more delay may be used for highly effective conditioning results. As we will see in our discussion of ecological perspectives on learning, conditioned taste aversion research by John Garcia has found that delay intervals of several hours may still result in effective conditioned responses being developed (Garcia, Kimeldorf, Hunt, & Davies, 1956). So the optimal time interval between NS/CS and UCS for effective conditioning all depends on what response is being measured and what ecological role that response plays in the physiological functioning of the individual or species.

This discussion of optimal ISI delay periods suggests that several

alternative procedures besides delayed conditioning might be investigated. Simultaneous conditioning is one example of a number of these possible variations. It involves the presentation of the neutral stimulus and the unconditional stimulus simultaneously (or at least under the effective requirement of being .5 seconds apart). Essentially, in simultaneous procedures the metronome and the food would be presented at exactly the same time to a dog. Of course, with the food always present, it isn't possible to tell whether salivation is occurring to the metronome or the food. But when Pavlov later tested the NS/CS by presenting the metronome alone, he found that the simultaneous procedure was not very effective for establishing conditioning. The metronome turned out to be generally ineffective in eliciting the UCR of salivation under simultaneous conditioning procedures.

Backward conditioning is another classical conditioning procedure that is defined from Pavlov's manipulations of the temporal relations between unconditional and neutral stimuli. In the backward procedure the neutral stimulus is presented only after the UCS is presented, usually in the same .5 -1 second time interval that is used in the delayed classical conditioning procedure. As in simultaneous conditioning, even after repeated pairings, the neutral/conditional stimulus is very weak and very unreliable, if effective at all, in its ability to elicit any conditional response as the result of backward pairing procedures.

A procedure, called the trace conditioning procedure, has also been explored whereby the NS/CS is presented and then terminated prior to the presentation of the UCS. Thus there is actually no time where the two stimuli are both present, but rather the UCS comes a short time after the NS/CS has already been terminated. As one might expect, this is not a very effective conditioning procedure, even though the example of lightning and thunder being associated is often mistakenly used as an effective illustration of classical conditioning. For one to come to fear lightning, the thunder clap must occur quite soon after the lightning has disappeared, thus assuring a minimum ''trace interval'' between the two (Pavlov, 1927/1960).

Pavlov even began to wonder if time itself could be used as if it were a stimulus in creating an effective conditioning procedure. In his many explorations he discovered that highly predictable (that is, regular or equal) time intervals between presentations of food alone would cause the animal to begin salivating when the appropriate interval of time had elapsed, even though no food was presented during such a ''test'' trial. It appears that the time interval itself is sufficient for the animal to demonstrate conditioning, and thus this procedure is called temporal conditioning. Many farmers are well aware that a regular feeding schedule will create quite a behavioral stirring or restlessness among livestock if a given feeding is a bit late, and this is an example of temporal conditioning.

Pavlov also investigated what would happen if the CS were presented for a number of trials without the presence of the UCS used for conditioning, but only after successful conditioning had already been established. He quickly discovered that the CR diminishes, and eventually disappears. This procedure is called extinction. The critical elements in the gradual disappearance of the CR is the occurrence of a conditional stimulus (for example, a metronome) that is no longer associated with an unconditioned stimulus (for example food) after successful previous conditioning trials.

In early extinction trials where the conditional stimulus occurs alone, the CS continues to elicit a conditional response. However, after repeated presentations of the CS alone, Pavlov found that the conditional response gradually diminished until it no longer occurred at all. It might reappear briefly on subsequent testing days -- a phenomenon called spontaneous recovery -- but that also quickly disappears. It is the parallel between conditioning and extinction as adaptive behavior suited to changing circumstances and the extinction of species when their behaviors are no longer viable for survival that gives the procedure extinction its name. The diminished or disappearance of the conditional response is extinguished behavior that parallels an extinguished species.

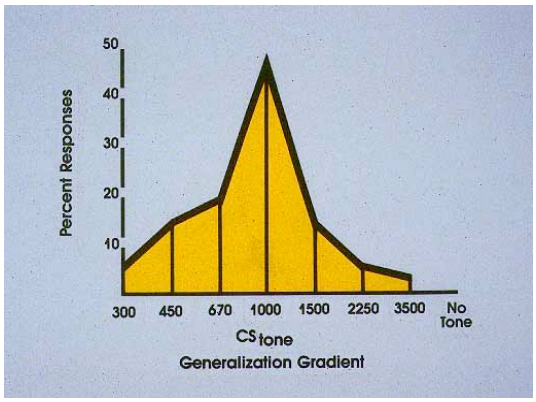
Pavlov also found that, following apparently complete extinction of a CR, if the UCS is paired with the CS again that CS quickly (often after only one pairing) regains its ability to elicit the CR again. The reappearance of a CR to the testing presentation of a CS would occasionally occur even without reconditioning, thus appearing to be a spontaneous recovery of the prior conditioning effect. It is from this reappearance that the phenomenon is called spontaneous recovery.

Pavlov also explored other procedures that were not reliant on time, but rather on stimulus similarities between several variations on the stimlus that was used as the NS/CS. Such explorations eventually defined a phenomenon called stimulus generalization and its inverse process of stimulus discrimination. It was from these investigations that Pavlov made some of his most dramatic discoveries, including one he referred to as experimental neurosis (Pavlov, 1927/1960). We shall thus turn to consider these non-temporal procedures in more detail.

Stimulus Generalization and Discrimination in Classical Conditioning

Pavlov made many interesting discoveries as he continued to explore alternative classical conditioning procedures, including some procedures that did not rely on time as the altered variable. For example, Pavlov investigated how his dogs might respond to stimuli that should be neutral, because those stimuli had never been paired with an UCS. In one variation of these conditions he noticed that

following successful conditioning which established a reliable CS-CR relation, if he presented stimuli that were both different from, yet similiar to, the original CS, these differing stimuli would elicit at least some amount of a conditioned salivation response even though these stimuli had never been present when food was available. For example, Pavlov's dogs responded with salivation to many different rates of a metronome ticking even though only one rate of ticking was used during conditioning. But the more dissimilar the tested rate was from the rate used for original conditioning, the less was the amount of salivation observed. Thisphenomenon is called stimulus generalization.



Stimulus generalization testing involves presenting test trials where many variations of rates of metronome ticking, and where each test stimulus variation differs somewhat from the original CS. However, these test stimuli are never paired with the UCS as the original CS was. Systematically testing many variations similar to the CS reveals a bell-shaped, or ''normal'' curve of declining amounts of salivation as the stimuli become more dissimilar from the original CS. This curve is called the stimulus generalization gradient (see illustration).

Pavlov then explored whether or not the animal would extinguish the partial responding to such similar stimuli. Repeated test trials were presented using one, and only one, rate of metronome ticking that was different from the CS and was never paired with food as an UCS. These ''extinction'' trials alternated with continuing conditioning trials where the original CS was presented and was still temporally paired with food as an UCS. In such conditions the similar CS that is not paired with the UCS is referred to as the CS- (the negative indicating ''not paired'') and the CS that continues to be paired with the UCS is referred to as the CS+ (the plus indicating ''is paired'').

This procedure defines what Pavlov called a ''differential conditioning'' procedure. This name comes from the experimenter's intent to test whether the animal can eventually learn to respond ''differently'' to the two ''different'' but similar stimuli. Explorations of many different variations of CS- stimuli were used for differential conditioning and revealed that presenting food only in the presence of one rate of metronome ticking (CS+ conditions) while another rate was presented several times and always without being paired with food (i.e., CS- conditions) results in extinction of responding to the CS- while continuing to respond to the CS+.

With such differential conditioning procedures Pavlov found that stimulus generalization is significantly altered. Both the CS- and other stimuli more similar to the CS- will fail to elicit the CR at all, while the CS+ and stimuli very similar to the CS+ continue to show conditioned responding. When differential conditioning first begins a CR occurs to many variations similar to the originally paired CS+, but after repeated extinction trials for the CS- the CR occurs only to those rates very close to the one being paired with food.

Pavlov noticed something which he considered highly significant during differential conditioning sessions involving a CS- that was extremely similar to the CS+, thus presenting the animal with a very difficult stimulus discrimination task. By ''very difficult'' we mean presenting two stimuli that have only the slightest differences, but only presenting food with one of them --as when an elliptical shape becomes very similar to a true circle shape and only a presentation of the circle is paired with food. During such difficult discrimination training sessions, Pavlov noticed that his dogs would become highly agitated and difficult to handle. Some even develop stomach ulcers and skin sores. Pavlov saw a parallel between this psychological source of physical illness and human psychological abnormalities and thus labeled this phenomenon ''experimental neurosis.''

Experimental neurosis made research measurements very difficult. The dogs would twist around and try to free themselves from the harnesses. They would also bite and develop painful sores on their bodies that were sensitive to touch. Pavlov realized that such symptoms as rigidity, agitation, skin sores and gastric ulcers were also observed in human individuals labeled as ''neurotic'' in his time, hence the name experimental neurosis. Outside of the laboratory, the dogs would be inactive and antisocial, just as some ''neurotics'' were. These problems occurred only during highly difficult discrimination, or ''conflicting'' tasks however, so this experimental form of conflict became a phenomenon studied extensively by Pavlov in both his animal laboratory and a human clinic he also maintained. This was the first of many subsequent applications of classical conditioning, and it is to some of these other forms of application that emerged following Pavlov's pioneering discoveries that we shall now turn.

Classical Conditioning Applications

Pavlov's detailed investigation of classical conditioning prompted him to explore the process' application for explaining the source of several types of human behavioral problems as well as for offering potential treatments. His work on what he referred to as experimental neurosis, brought about by difficult differential conditioning, has already been discussed in a previous section (Pavlov,

1927/1960). Later researchers in classical conditioning found many more practical applications as well. One of the earliest was the team of John Watson and Rosalie Raynor, who investigated the development of conditioned emotional responses, such as fear (Watson & Rayner, 1920).

Watson and Raynor studied not only how fear developed, but also how it generalized by exposing infants to furry animals paired with loud noises that elicited startle responses and crying. Their most famous subject, named Little Albert, served as a model for how phobias might develop in all humans (Watson & Rayner, 1920). John Watson subsequently went on to become a very successful and significant figure in the American advertising world where he used his knowledge of classical conditioning to change consumer attitudes through stimulus pairings that appear in various forms of advertising (Watson, 1936).

Other classical conditioning applications have tried to prevent coyotes from killing livestock (Gustavson, Garcia, Hawkins, & Rusiniak, 1974). Farmers have used basic laboratory work by John Garcia on conditioned food aversion to chemically laced sheep carcasses to make coyotes sick enough to avoid eating these animals in the future (Garcia, Kimeldorf, Hunt, & Davies, 1956). Conversely, doctors have used classical conditioning in conditioned immune response procedures to allow a patient to have an optimally functioning immune system with the least amount of medication possible (Buske-Kirschbaum, Kirschbaum, Stierle, Jabaij, & Hellhammer, 1994).

Classical conditioning procedures have psychotherapeutic value as well. Phobias are often treated with a process stemming from classical conditioning called systematic desensitization (Wolpe, 1958). Alcoholism and other addictions are also treated using a form of classical conditioning. From research on fear to applications in advertising, treating phobias, and keeping coyotes from killing sheep, the processes discovered by Pavlov have proven crucial in our understanding of how organisms learn and respond physiologically and emotionally to events around them. This understanding has led us to better therapies and effective uses of classical conditioning techniques.

Finally, there is another important application for the stimulus contingency that exists between a CS and an UCS in classcial conditioning. Virtually any UCS will also have reinforcing functions for another form of conditioning called operant conditioning. And any stimulus that predates an UCS in a reliable manner, as the CS does in classical conditioning procedures, will also come to have a similar reinforcing functionality called conditioned reinforcement (also known as secondary reinforcement). Thus one of the most important applications of classical conditioning is this development of the CS's conditioned reinforcement function. This allows a CS to serve as a reinforcer in operant conditioning and thus broadens the scope and power of that conditioning process

very significantly. We will revisit this other application of classical conditioning, especially as it relates to what is sometimes called ''magazine training,'' when we discuss how one can develop a new behavior using a special process in operant conditioning called response shaping. So expect to read more about this unique application of classical conditioning in a subsequent section that explains magazine training in its context of operant response shaping and conditioned operant reinforcement (Skinner, 1938).

Conditioned Emotional Responses

As noted in the introduction of classical conditioning principles, one of the more significant applications of Pavlov's procedures is an understanding how human fears develop and generalize. To demonstrate, empirically, that fear can be conditioned, Watson and Raynor (1920) performed an experiment that continues to be a classic demonstration in the history of psychology.

First, Watson and Raynor allowed an 11-month-old child, nicknamed Little Albert, to play with a white, lab rat. While he was playing with the animal, the researchers produced a loud noise (usually with loud cymbals) behind Little Albert. This startled him and he would cry. After several pairings of the rat (neutral stimulus) and the noise (an UCS for bringing about startle response and crying--the UCR), Little Albert began to cry (now a CR) at the sight of the rat (now a CS) without the noise.

Little Albert also cried at the sight of a white rabbit and a furry Mardi Gras mask (an example of stimulus generalization), but not at white paper or white cloth (stimulus discrimination). This experiment was one of the first to demonstrate the role of conditioning in the origin of fear and phobias (Watson & Rayner, 1920).

This study was incredibly important to our understanding of fear and how emotions can be conditioned. However, some feel that this knowledge came at too high of a price for Little Albert. After the experiment, Little Albert never came back to the laboratory and no one knows how the experiment effected him as he grew older. Watson and Raynor's study, while very powerful and important, would be considered unethical today and would not be allowed to commence.

Fear is one of the major emotions studied in the area of conditioned emotional responses, but it is not the only emotion that can be transferred from being elicited by truly unconditional stimuli to being elicited by conditional stimuli because of past pairings between the two. Virtually any emotion can become conditioned. For example, if you were given a gift for a major achievement, you may come to have positive and joyful feelings whenever you look at the gift in the future because of its pairing with such a happy time in your life. While the focus of

this section is on fear, it is important to remember that conditioned emotional responses are not limited to fear alone.

Nevertheless, fear is an extremely important example of conditioned emotional responses. When fears become strong or generalized enough to negatively affect one's life, they are labeled phobias. Phobias often interfere with a person's everyday life and can be very maladaptive. True phobias should not be treated lightly and they often call for treatment. Some people will state that they have a phobia, when in fact, they only have a simple aversion or fear. For example, someone who states that they have a phobia of spiders, but simply avoids or kills them probably has a strong dislike or aversion, but not a phobia. Someone who runs out of their house and then begins to cry uncontrollably because they saw a small spider on the floor probably has a phobia, in this case, arachnophobia.

Like simple fears, phobias are conditioned and generalized through experience with pairings of stimuli in one's environment and are included as a conditioned emotional response. Because phobias arise from conditioning, therapy for phobias usually also involves classical conditioning procedures, such as systematic desensitization. These procedures may extinguish phobic responses or even classically condition new and more positive responses to the stimuli. Thus, new emotional responses that are incompatible with and replace the fear can also be classically conditioned (Wolpe, 1958).

Conditioned Taste Aversion

Another application of Pavlov's classical conditioning procedures is that of conditioned taste aversion. Like conditioned emotional responses, taste aversion can be conditioned through everyday experience of chance pairings between neutral and eliciting stimuli in the natural environment. Organisms can come to avoid certain foods/tastes through classical conditioning principles, and almost every human has had such an experience. What favorite food did you get sick on once and now can no longer eat, no matter how hungry you are? If you don't have one you are somewhat unique in your good fortune!

John Garcia , one of the first to study the phenomenon of conditioned taste aversion, demonstrated this with rats in a laboratory (Garcia, Kimeldorf, Hunt, & Davies, 1956). In Garcia's experiments, rats would freely drink water (a NS) in their own cages. During an experiment some of these rats would be transferred to experimental cages also containing water, but also where x-rays were present in these test cages. Exposure to these x-rays (UCS) produced nausea and sickness (UCR) in the rats. With time, the rats would not drink in these test cages.

Garcia noticed that the water bottles in these cages were plastic while those in the home cages were glass. Plastic water bottles are known to give the water in them a distinct taste (a CS), while the water in glass bottles is virtually tasteless. Garcia concluded that the x-ray induced nausea was becoming classically conditioned to the taste of the water in these plastic bottles but not with the tasteless water of the home cage bottles (an inadvertent creation of differential conditioning procedures). Because nausea is an unpleasant response, the rats in the experiment came to avoid the water with plastic taste hence the term conditioned taste aversion. It is thought that conditioned taste aversion has important survival value, as the process prevents organisms from eating potentially dangerous foods that have similar tastes or odors to the ones that have made them ill in the past (Garcia et al., 1956).

One use of Garcia's conditioned taste aversion findings is that of predator control. Predator control uses food aversion instead of an aversion to a liquid, however. Conditioning as an approach to predator control efforts began with an argument between sheep farmers and environmentalists in the Western United States. The debate was over what to do with coyotes that were appearing on the farmers' land and killing and eating their livestock, especially sheep. This problem cost the farmers tremendous amounts of money and they felt the only solution was to shoot and kill the coyotes when they attacked sheep. The environmentalists felt that this was inhumane and harmful to the environment as the coyotes the farmers were shooting were already endangered. Both sides had reasonable arguments and it was an application of classical conditioning procedures in the form of conditioned
taste aversion that began to solve the problem.

The farmers were instructed to leave poisoned sheep carcasses around the perimeter of their pastures. The poison used is thiamene, a tasteless drug that causes extreme nausea and vomiting. When coyotes ate the poisoned meat they became very sick. Soon, they came to associate the sight and smell of sheep with the actual taste of the meat that had elicited their illness so they avoided eating sheep. This processes is a more humane way of controlling predators and is a solution, based on classical conditioning, that is considered much more humane than killing the coyotes (Gustavson, Garcia, Hawkins, & Rusiniak, 1974).

The effectiveness of food aversion on predator control has had mixed reports, however. Some farmers reported that coyotes didn't eat mutton anymore, but they still continued to kill the sheep. On the other hand, some farmers reported complete success with the process. Of course every new generation of coyotes has to be conditioned in a similar fashion, since learning and conditioning is only an individual adaptation that doesn't extend to new generations. While most farmers agree that the application of taste aversion has lessened the problem, it has yet to

be seen as a complete solution. Some farmers are still forced to resort to shooting the coyotes when they attack their livestock (Timberlank, & Melcer, 1988).

Taste aversion therapy is an application of classical conditioning procedures that uses aversive, or unpleasant, stimuli to counteract undesirable and even maladaptive behaviors. Addictions are such behaviors in humans. So aversive conditioning has been explored as a treatment for addictions. This form of therapy usually involves conditioned taste aversion principles developed by Garcia, but it is not a necessity. In the treatment of the addiction to alcohol, or alcoholism, the unpleasant feeling of nausea is paired with the consumption of alcohol. What eventually results is an aversion, or avoidance, of alcohol. The process, typically referred to as antabuse treatment, is not perfect, as at times the individual suffering from alcoholism does not follow the procedures 100% of the time.

First, an individual with alcoholism is given a drug that they must take every day. Antabuse drugs have no effects unless the person drinks alcohol. If the person drinks, the antabuse drug reacts with the alcohol to create an extreme feeling of nausea (thus the antabuse drug plus alcohol is an UCS for the UCR of nausea). Following repeated pairings alcohol (now a CS) comes to elicit nausea (now a CR) without the antabuse and the person avoids the taste of alcohol by not drinking. This process has shown to be effective, but it is not a perfect solution. One of the problems with aversion therapy, even though it has proved to be successful in the treatment of addictions, involves its unpleasant nature and the inclination of some individuals to resist or avoid treatment. Likewise, a person addicted to alcohol may stop taking the antabuse drug so that they can drink with no consequences. It takes much effort on the part of the patient to overcome an addiction with aversion therapy (Forrest, 1985).

Systematic Desensitization

Classical conditioning as it occurs naturally in our everyday lives can, quite by chance, result in strong conditioned emotional responses ranging from simple fears to even more extreme and generalized fears called phobias (Watson & Rayner, 1920). Early approaches to treatment thus emphasized the importance of facing the feared stimulus in he absence of any harmful or feared unconditional stimulus, thus creating a forceful and sometimes highly uncomfortable extinction process. Such radical procedures were sometimes referred to as flooding or use of the bronco-busting technique in recognition that this is exactly how early cowboys eliminated the fear of having a rider on the back in a horse. In real treatments circumstances, such as the clinic, this approach more often results in not having

the patient return for required successive extinction treatments than in successful treatments!

So one of the more popular conditioning-based treatments for phobias added a more gradual dimension to this extinction process. Such a gradual approach uses what is called systematic desensitization techniques. This is very close to the techniques used by what are sometimes called horse whisperers for dealing with a horses fear of being ridden or handled using procedures that are quite different from bronco busting or flooding.

The application of systematic desensitization techniques, as well as its more technical name, originated with Joseph Wolpe. Systematic desensitization is a set of methods for eliminating fear through extinction, but it frequently adds another conditioning dimension for actually replacing fearful reactions to stimuli with more positive and adaptive responses. This replacement process is accomplished through the added use of a special form of classical conditioning called counter conditioning, which involves classically conditioning positive reactions that are incompatible with the more negative fear response to feared stimuli.

Systematic desensitization is often very successful in treating a wide variety of phobias. It has even been well received in the treatment of agoraphobia, fear of open and/or public places. This phobia is complex and is often linked to those who suffer general anxiety disorders. When counter conditioning is also used in systematic desensitization, an individual not only experiences extinction of the previously learned fear reaction but also simultaneously acquires a new response to a specific CS (in the case of arachnophobia, a spider). This new response to be learned is more adaptive than, and is literally incompatible with, the original fear response (Wolpe, 1958).

Phobic and anxiety reactions involve an activation of the sympathetic nervous system, which includes large secretions of adrenaline into the blood stream along with an elevated cardiovascular arousal where the heart beats more quickly and noticeably. The person may tremble and also break out in a sweat. This sympathetic nervous arousal process occurs simultaneously with an associated decrease in parasympathetic nervous activity. Parasympathetic activity is normally experienced with more positive feelings of mild sexual arousal, relaxation, and heightened digestive activity. Thus the goal of counter conditioning for phobias is not only to decrease sympathetic arousal elicited by feared stimuli, but also to condition an elevation in the parasympathetic nervous activity that is incompatible with this normally elevated sympathetic activity.

The process of systematic desensitization involves several successive steps. First, the client and the therapist break up the process of approaching the feared object into many small steps. These steps go from exposing the client at first to

the least stressful stimulus, and only gradually moving to the most stressful stimulus that elicits the clients fear. For example, a client may break up handling a spider into several gradual steps that successively approximate the eventual handling behavior. The first step may be as simple as the client merely talking about spiders. After the client can comfortably use the word spider, the therapist may move to having the client imagine seeing a spider from a safe and relatively comfortable distance. Then the client may progress to being able to imagine approaching the spider. Gradually, still photographs, then moving pictures, and perhaps even rubber models of spiders might be used in progression. Throughout each step, patients are taught to evoke relaxation responses using specially taught relaxation techniques to produce parasympathetic responses that are incompatible with fear responses.

Gradually, through both the extinction of sympathetic arousal responses plus the pairing of the feared stimulus at each step with stimuli that evoke relaxation, the feared stimulus (i.e. spider) comes to elicit relaxation instead of fear behavior. Eventually, the client can reach the last step, touching or handling the spider. When the individual can complete this reliably, the phobia is fully treated.

While some clients may have handling a spider as their last step, others simply work to a goal of tolerating being in the same room with one and calmly getting someone else to kill it (or if they live alone, they learn to kill it themselves). Phobias are different for everyone and it is important to keep in mind that the point of systematic desensitization is not to get people to love the feared stimulus. It is to condition them to have adaptive behaviors in response to the feared stimulus even is a great dislike or a mild aversion still exists. Of course this is not to say that some who are extremely afraid of getting their face under water because they cant swim don't end up being avid swimmers after overcoming their phobic reactions! It all depends on the life style and desires of the client in overcoming their problems (Wolpe, 1958).

Conditioned Immunity

Applications of Pavlov's classical conditioning principles include a very broad range of real world situations that give rise to personally significant physiological reactions. From conditioned emotional responses such as fear and phobias to taste aversions that almost every individual uniquely has acquired, conditioning can be seen to occur naturally in our everyday world. Likewise, contrived and manipulated stimulus pairings pervade our lives, such as when advertising presents beautiful people having fun or obtaining joyful relief (UCS) because of some product where

the brand is a prominent (conditional stimulus). But even the human physiological immune response is subject to classical conditioning.

Thus Pavlov's conditioning procedures have been applied in medicine in order to improve immune functioning. Researchers have shown that after several pairings of a drug that increases the immune response, such as epinephrine, (an UCS) with a placebo of a certain taste or smell (neutral stimulus) the placebo (now a CS) will increase the immune response (now a CR) when presented alone. This is a useful phenomenon, as doctors can give only a placebo in between scheduled drug injections, thus increasing the body's immune response to infection with a minimal amount of drugs (Buske-Kirschbaum, Kirschbaum, Stierle, Jabaij, & Hellhammer, 1994).

A placebo is any substance that does not initially have the effects of a particular drug. A sugar pill is often used as a placebo in drug studies. In the case of classically conditioned immune responses, anything with a distinctive taste, sometimes a certain flavor of ice cream, can serve as a placebo or, in other words, a neutral stimulus. When repeatedly paired with an UCS that elicits an immune response (usually epinephrine), the placebo (such as ice cream) can elicit the response when presented alone. This is very powerful, but it can also lead to problems if something were to be conditioned to suppress the immune system instead of boost it.