



APDT

NEWSLETTER

Building Better Trainers Through Education

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Joan Maxwell
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The Science of Animal Training

by Marian Breland Bailey, PhD, and Robert E. Bailey

Editor's note: We are pleased to dedicate this issue to an overview of operant conditioning—its grounding in science, its fundamental principles, and how behavior is analyzed by scientists. In two articles—this cover story and a second piece on the ABCs of behavior—behaviorists Marian and Bob Bailey summarize operant conditioning in a way that should be helpful to novice and experienced trainers alike. They whet our appetites for all there is to know, and all that is yet to be learned.

We extend our deepest thanks to the Baileys for their contributions. Be sure to watch for their articles in future issues, too, where they'll talk about common myths and the application of operant conditioning in dog training. For a biographical sketch of the Baileys, please see "Meet the Baileys" on page 11.

Yes, Virginia, there is a science behind modern animal training. It's called operant conditioning (OC)—more precisely referred to as behavior analysis—and includes a method of behavior modification and therapy based on laboratory science. Scientists who study behavior have been undertaking extensive science-based research and gathering volumes of data on behavior analysis since the early 1930s.

Although B.F. Skinner is the acknowledged originator of operant conditioning, the roots of this science go back to the turn of the century. Early researchers such as Edward Thorndike, Ivan Pavlov, and John Broadus Watson contributed to the evolution of our present-day understanding and application of behavior analysis.

FROM THORNDIKE TO SKINNER (1900 TO 1940)

The experiments of psychologist Edward Thorndike addressed the mechanical problem-solving ability of cats and dogs and whether or not

animals could learn through imitation, trial and error, or observation. By 1910 Thorndike had developed a law of psychology—the law of effect—that attempted to explain behavior in terms of stimulus-response and satisfaction/discom-

fort associations. The law of effect stated that behaviors that lead to satisfying outcomes were more likely to be repeated, while behaviors that lead to undesired outcomes were less likely to be repeated.

Psychology professor and researcher John Broadus

Watson basically bypassed Thorndike's law of effect. Instead, Watson seized the Russians' (Pavlov and Bekhterev) work on the classical conditioning paradigm as the scientific cornerstone of his "behaviorism." (We are most familiar with classical conditioning as the type of learning made famous by Ivan Pavlov's stimulus-response (S-R) experiments with dogs.) With the 1919 publication of his major book, *Psychology from the Standpoint of a Behaviorist*, Watson became the founder of the American school of behaviorism.

**"... the roots
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The Science of Animal Training

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During the 1920s, Watson became more involved with practical applications of psychology (in advertising and marketing) and did not extend his early work on behaviorism. However, the “behavioral genie” was out of its bottle and, during the 1930s, others pursued animal behavior and its consequences.

Chief among psychologists studying animal behavior at this time were the neobehaviorists, the “new” behaviorists, who adopted Watson’s main principles of objectivity and the study of overt behavior while developing their own variations on Watson’s theme. Most also tried to adapt Watson’s model of classical or Pavlovian conditioning to the more important, everyday behavior of animals and humans.

While B.F. Skinner has become the most famous and influential of the neobehaviorists, others developed a following. Tolman, Hull, and others also studied animal behavior. For a number of reasons, behaviorism, led by the neobehaviorists, gained strength through the 1930s and 1940s, perhaps paralleling the general rise of science, and became the dominant “system” of psychology. Skinner’s view was finally to prevail because he put aside the Pavlovian paradigm as the center of his system, developing his own scientific description of how behavior changes. His system also worked in the real world, a significant contrast to most other “psychologies” of the time.

The point of all of this is that behaviorism, and the neobehaviorists’ view of behavior, is not monolithic. Operant conditioning, which we are discussing here, is not the only behavioral psychology.



(l-r) B.F. Skinner, Bob Bailey, Marian Bailey (circa 1987)

Behaviorism, and mostly Skinner’s version—operant conditioning—dominated psychology until the 1970s and ‘80s. In the 1980s, the so-called “cognitive revolution” began to color psychologists’ thinking and teaching, but not their practical achievements. Today, practical applications of so-called “cognitive psychology” look suspiciously like operant conditioning with different wrappings.

In 1938 B.F. Skinner published *The Behavior of Organisms: An Experimental Analysis of Behavior*, arguably the most influential work of the century on animal behavior. Skinner’s approach focused on everyday behavior instead of involuntary physiological reflexes. Thus, he moved away dramatically from the behaviorism models of John Watson and Ivan Pavlov that had emphasized the psychology of stimulus-response, and embraced the theory of natural selection of successful responses through their consequences to humans and other

species. This fact should be noted by those who dismiss OC as merely stimulus-response or as a simple extension of respondent conditioning.

OPERANT CONDITIONING ACCORDING TO SKINNER

Let’s take a look at the original basic principles of operant conditioning as laid out by Skinner’s landmark book, *The Behavior of Organisms*.

Operant conditioning concerns the changing of motor actions and action patterns. These are fancy names for things that we do in our normal working day—our so-called voluntary movements. Keep in mind that this focus on *voluntary* movements is a big switch from earlier research that focused on *involuntary* physiological reflexes.

Skinner shrewdly reasoned that most everyday behavior—such as studying, mowing the lawn, or going shopping or to a movie—does not fit the Pavlovian S-R model. There is no single, outstanding



stimulus to which one can point that elicits, automatically, any of those behaviors. Rather, the responses that make up our everyday behavior grow stronger and survive as the result of our operation on the environment—hence, the designation “operant” for these responses. In other words, reflexes may allow us to control our blood pressure automatically, but learning operant behaviors allows us to cope with our surroundings.

BEHAVIORAL CONSEQUENCES

Skinner recognized that an operant behavior could have three possible consequences:

- good (reinforcing)
- bad (aversive)
- neutral, or none (extinction)

This analysis of potential consequences is one of the beauties of operant conditioning, offering a simplicity and clarity available in no other behavioral methodology. Things can get better, get worse, or stay the same—all depending on the circumstances.

According to Skinner, behavioral consequences are measured by the rate of response; that is, how often a response occurs per unit of time. Skinner said that a reinforcer is any object or activity that causes a response to increase in strength (rate or probability of response). In other words, the occurrence of reinforced behavior increases (or sometimes maintains its rate), while the occurrence of non-reinforced behavior decreases.

REDUCING BEHAVIOR

There are two ways of reducing behavior: ignoring it and punishing it. If a behavior is not reinforced in any way, it will decrease in frequency. Thus, if nothing occurs inside or outside the animal that reinforces a behavior, the probability is that the behavior will reduce in

strength or happen less often. The process of reducing behavior due to lack of reinforcement is called extinction.

Applying an aversive stimulus (punishment) when administered by a human or another animal will also decrease behavior. Actually, the very definition of whether a stimulus is aversive or punishing rests on the decline of behavior. If applying the stimulus results in the decline of a behavior, that stimulus is classed as an aversive, or a punisher. It is also true that if a stimulus increases the rate of behavior, that stimulus is a reinforcer. Thus, the nature of a stimulus, reinforcing or aversive, is defined by the behavior of the animal and not by a decision of the trainer.

“Operant conditioning is a science that has given us the tools to study and predict behavior and, ultimately, to influence, if not completely control, a given behavior.”

OC IS SIMPLE

Are you grasping the point that OC is made up of simple concepts, practices, or principles? You might argue, “It can’t be that simple.” But it is. By combining these practices and some others, you can increase or decrease most behavior and

selectively shape just about any behavior possible for a given animal. Operant conditioning is a science that has given us the tools to study and predict behavior and, ultimately, to influence, if not completely control, a given behavior.

Applied behavior analysis is not exactly synonymous with applied operant conditioning, anymore than behavior analysis is not exactly the same as operant conditioning. Operant conditioning, as a science or as a technology, is the study, prediction, and control of operant behavior. Respondent conditioning has to do with respondent (largely reflex) behaviors, not operant behaviors. Behavior analysis includes both operant and respondent behaviors and their interactions. We, the Baileys, view behavior as more or less a continuum between what has been thought by many to be totally separate camps, operant and respondent. For this discussion, however, we do not wish to split hairs and will accept OC as synonymous with behavior analysis.

When we teach animal trainers, our position is that OC is “simple but not easy.” The animal decides what is reinforcing and what is punishing. Not all reinforcers are under the direct control of the trainer (there are internal as well as external events leading to reinforcement). The animal decides the meaning of cues. The animal is always right. The trainer’s challenge is to observe the animal, communicate with the animal, and respond to the animal. Yet, all the while, the trainer must be in substantial control of the animal’s behavior in order to ply his or her craft. This is the reason for our “simple but not easy” view of OC, and probably why many find OC difficult to apply.

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The ABCs of Behavior

by Marian Breland Bailey, PhD, and Robert E. Bailey

The “ABCs of Behavior”—meaning the antecedents, behavior, and consequences—is a shorthand expression used by behavior analysts since the 1960s. Before behavior analysts, or trainers, begin to build a new behavior or change an existing one, they carefully examine the content of each of these elements. This helps to determine what may be causing a behavior, as well as how to change it.

A IS FOR ANTECEDENT

“Antecedent” refers to anything that precedes the occurrence of the behavior. In the dog training world, we are most familiar with antecedents that are stimuli—such as an odor, a high-pitched sound, or a trainer’s verbal cue—in short, any change in physical energy that the dog can perceive or react to.

Stimuli present themselves to the dog in different forms. Let’s talk about two of those forms: background/context stimuli and salient stimuli.

BACKGROUND/CONTEXT STIMULI

This form is the entire array of stimuli—the context—that greets the dog as he encounters a situation in which behavior is going to occur. These stimuli might include sounds, odors, and visual cues, or any combination of vision, hearing, touch, temperature change, pain, head movement, and balance. It includes the trainer and any other individuals present, and their movements. Of this total array of stimuli, most may be totally irrelevant or meaningless to the dog at a given time. In some situations, however, the dog may react to one or more important stimuli, which we call the salient stimuli.

SALIENT STIMULI

The word “salient” means outstanding or prominent. Stimuli

can become salient in one of two ways:

- Natural salience: where the dog comes with a genetic tendency to pay special attention to certain stimuli (e.g., a German shorthair pointer being stimulated by the rustling of a pheasant in a field).
- Learned or conditioned salience: where the dog is exposed to a stimulus that is paired with primary or strong secondary reinforcers or aversives (e.g., the sound of a kitchen can opener that precedes the dog’s meal, the word “No!” shouted by an owner as his dog moves toward a ham sandwich on the kitchen counter).

Regardless of how stimuli acquire their salience, they can become the most important variable in a training scenario. For shaping or modifying a behavior, the trainer should have control over these salient stimuli. If a stimulus in the whole array of background stimuli is more salient than those being presented by the trainer, that trainer is in trouble because she is losing stimulus control over her animal.

For example, a trainer may discover to her chagrin that an incidental arm movement causes the dog to emit a response prematurely. In behavior analysis parlance, that arm movement is a context stimulus; however, it is more commonly referred to by trainers as a “secondary cue.” Context stimuli are always present, so trainers should take precautions to stand or sit very still and supply no extraneous stimuli while training.

PREVIOUS CONDITIONING HISTORY

Another important antecedent of behavior is the dog’s history. If you have raised a pet yourself, you more or less know what has happened to

him in the past. But quite a different situation occurs when the dog has spent time in a pound, an animal shelter, or an abusive home. If you give a cue or command to sit and the dog responds, you can probably assume that this behavior was part of the dog’s previous training history. Likewise, if the dog is fearful of specific objects such as sticks or walking canes, there is a good chance that the dog has encountered these objects in an unpleasant framework.

The more you know about the dog you are training, the greater your advantage in determining how to change behavior.

ESTABLISHING OPERATIONS

Yet another form of antecedent is an “establishing operation,” also known as a “setting factor.” The general definition of an establishing operation is a condition that changes the value of a reinforcer and, thus, increases the likelihood that certain responses will increase or decrease. For example, if a dog deprived of food becomes more hungry than usual, the value of the food will increase; the dog will perform behaviors that have resulted in food in the past. The dog also will work harder to get the food.

Other establishing operations may include availability of water, changes in climate, hormonal changes, and various health conditions (e.g., a dog with digestive tract problems might typically show no interest in food).

B IS FOR BEHAVIOR

When we talk about a dog’s behavior that occurs in response to antecedents, we’re referring to the behavior’s function—what the behavior does for the dog or, in other words, the consequence of the behavior. We are also talking about



all the responses and sub-responses that take place in the instance of behavior occurring.

For example, a dog trainer may have a problem with his dog not being able to clear a high hurdle. The trainer may analyze a behavior called, perhaps, "hurdle jumping." Clearly, such a behavior consists of a number of responses such as getting into the starting position, running toward the hurdle, gathering limbs into the jumping mode, springing over the hurdle, and landing.

The trainer's goal is to evaluate each response individually and try to identify a specific sub-response that's causing the problem. For example, he may videotape the jump and notice that one of the dog's legs is poorly angled for best propulsion of the body into the leap. In that case, he can use shaping techniques to work the leg into the proper position.

Regardless of the complexity of the behavior, analysis of the responses and sub-responses allows the trainer to plan the training periods and sessions. Planning of this sort can give the trainer a huge advantage over a haphazard trainer who may approach the problem with no analysis and no plan.

C IS FOR CONSEQUENCES

As we mentioned in the "Science of Dog Training" article beginning on page 1, an operant can have any one of three consequences:

1. reinforcement
2. aversives (punishment)
3. extinction

REINFORCEMENT

Reinforcement, which can be either positive or negative, is the process of strengthening the operant that produces a desired consequence. The reinforcer can be the natural result of the dog's behavior in its everyday environment, or perhaps a

treat given by a trainer for a properly executed response.

Positive reinforcement involves the presentation of a good consequence when the response is performed (e.g., you say "Come," the dog comes, and you offer a treat). It increases the likelihood that the behavior will occur in the future.

***"Extinction ...
represents the surest,
most permanent,
and most humane
way of eliminating
a behavior."***

Negative reinforcement involves the removal of a bad consequence when the response is performed. Many dog trainers are familiar with the ear pinch used in a forced retrieve to compel a dog to take the dumbbell in his mouth; this is the use of negative reinforcement. When the dog takes the dumbbell, the ear pinch is stopped. As with positive reinforcement, negative reinforcement increases the future likelihood of the behavior that removes or avoids the aversive.

AVERSIVES (PUNISHMENT)

Not all operants are so fortunate as to be followed by reinforcers that strengthen responses. One type of consequence—an aversive—not only weakens the behavior it follows, but can actually deal it a deathblow to the extent that the behavior may never reappear.

There are two categories of aversives: primary and secondary. Primary aversives, like primary reinforcers, have their roots in natural substances

or occurrences (e.g., an event that causes tissue damage or an intolerable odor). Secondary aversives, like secondary reinforcers, become what they are by association with the "real thing" (e.g., the word "No!" paired with a slap).

Aversives in general, and punishment in particular, may have bad consequences for the dog and trainer. They can produce uncontrollable fear, not only of the trainer, but the entire training situation. Aversives can suppress virtually all behavior. They may also encourage aggressive responses. More acceptable alternatives, such as reinforcement, should always be considered before using aversives.

EXTINCTION

Extinction refers to the gradual weakening of a previously reinforced response when it is no longer reinforced. This represents the surest, most permanent, and most humane way of eliminating a behavior. For example, a dog kept in a yard discovers that by pushing on a certain board near the gatepost, he can make the gate open. On several occasions the dog gets out this way and enjoys romping through the neighborhood. Finally, the dog owner fastens the board so that the dog can no longer open the gate with a push. The dog keeps pushing unsuccessfully at this board, time after time, until gradually the response of pushing disappears.

When using extinction to eliminate an undesired behavior, it is important to train a substitute behavior. Teaching a dog to sit instead of jump up on visitors is a good example.

Two things may happen in the course of extinction that sometimes discourage trainers who are trying to use this method to get rid of a problem behavior. The first of these is the "extinction burst," a sudden

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occurrence of several rapid emissions of the response in question. For example, the dog who has almost given up pushing the board may suddenly emit several quick pushes. This extinction burst can occur any time during the extinction process. In fact, such a burst often occurs at the beginning of an extinction period (or training session). Many novice trainers observe the burst and then conclude, erroneously, "See, extinction does not work. The response has become more frequent and faster."

The second thing that may happen is "spontaneous recovery." After an initial extinction session, the

response may appear to be completely gone. A period of time later—a few hours, overnight, perhaps longer—the dog again offers the response in a training session.

Neither extinction bursts nor spontaneous recovery are incidences of the dog testing the trainer or being stubborn. Rather, each is a normal phenomenon that occurs in the process of changing behavior.

Extinction often encourages variability of behavior, allowing new responses to appear and receive reinforcement. Many experienced trainers take advantage of this phenomenon. For example, a

trainer who wants to increase the energy a dog puts into a response may be able to "catch" some of the vigorous responses caused by an extinction burst, reinforce them, extinguish the weaker responses, and build to a generally more powerful response that can then be put under stimulus control, (i.e., on cue).

Extinction may occasionally induce a small amount of aggression, but nothing like that which occurs with the use of punishment. Extinction also does not seem to create the fear present in the animal after use of aversives. Hence, it is preferable as a means of weakening or eliminating behavior. 🐾

OC DEFINITIONS AT A GLANCE

Operant Conditioning: a naturalistic, scientific description of how animal behavior changes—in other words, how animals learn; an objective science that emphasizes quantitative data, replications, verification, and follow-up

THE ABCs OF BEHAVIOR

These are the elements of behavior that are analyzed to determine how to best change an animal's behavior.

Antecedent: something that happens before the behavior occurs; the most common of these are stimuli, establishing operations, and previous history

Establishing operation (EO) or setting factor: an operation or event that changes the value of a reinforcer and increases the strength of all responses pertaining to that reinforcer

Behavior: anything an animal does

Consequence: the result of an animal's behavior

THE FUNDAMENTAL PRINCIPLES OF OC

Trainers who use operant conditioning apply five fundamental principles. Each of these principles describes a process that alone, or in combination with others, provides trainers with essential tools in changing behavior.

Stimulation: a change in physical energy to which an animal can respond or that an animal can perceive with its sensory organs (e.g., vision, touch, hearing)

Reinforcement: the process of strengthening the behavior that produces a desired consequence; can be either positive or negative

Extinction: the gradual weakening of a previously reinforced response when it is no longer reinforced

Aversive: a consequence that weakens the behavior it follows; also called punishment when applied by a human (trainer, parent, etc.) or another animal (usually a conspecific, e.g., a mother bear cuffing her cubs)

Generalization: the ability of an animal to learn to respond to a range of stimuli rather than to a single stimulus ("stimulus generalization") and the ability to learn to perform a certain behavior or group of behaviors in response to a specific stimulus ("response generalization")

Editor's note: Please refer to the Sep/Oct 2001 issue for definitions of positive reinforcement, negative reinforcement, positive punishment, and negative punishment.

Meet the Baileys

Marian and Bob Bailey are applied behavior analysts. Some people might call them operant trainers.

Marian, one of B. F. Skinner's early undergraduate and then graduate students, holds a doctorate in psychology and was a university professor for almost 20 years. Bob, who holds degrees in chemistry and biology, pioneered operant-based animal training methods in free-environment and production settings.

Marian began training animals in 1938, and she trained her first dog in 1941. She was the first person to apply operant conditioning commercially. Bob began training in the late 1950s and was a pioneer in the open ocean use of dolphins while he was the Director of Training for the U.S. Navy.


The Baileys have trained over 15,000 animals representing more than 140 species in the past 50+ years. Among these are numerous dogs for commercial, research, and military applications. Large segments of their work have



(l-r) Bob Bailey, Marian Bailey, and student

involved releasing trained animals (both birds and mammals) in environments that are sometimes hostile and always distracting.

Although the Baileys are retired from business and from academic teaching, they consult, lecture, and conduct workshops on applied

behavior analysis. They are currently documenting the history, science, and practices of operant conditioning and behavior analysis. When teaching, they often use chickens as behavioral models. For more information, go to www.hsnap.com/behavior. 

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OC IS NOT A THEORY

Many people believe that operant conditioning is just a theory. It is not. Operant conditioning is a naturalistic, scientific description of how animal behavior changes—in other words, how animals learn.

Skinner's book, *The Behavior of Organisms*, contains his observations

of how rat behavior changes as circumstances change. Some of his later books were elaborations or extensions of the same observations. Skinner did not postulate or speculate on the reasons or mechanisms of such changes. As a personal aside, in our private conversations with Skinner, he did not hold theorizing in high regard, rather preferring the

gathering and analysis of data. As a science, OC is objective and open to the world, and it emphasizes quantitative data, replications, verification, and follow-up. As a technology, it is a powerful tool for changing behavior. On a personal level, we earned our livings using it for almost half a century. 