

## B. F. SKINNER AND OPERANT CONDITIONING

The major problems of the world today can be solved only if we improve our understanding of human behavior.

B. F. Skinner

B. F. Skinner became, and remained, by far the most influential spokesman for an uncompromising behaviorism: psychology is about behavior, not about the mind, and not about the nervous system. It deals only with variables that can be directly observed, and its task is to show how behavior is related to the variables that influence it. He and his students and collaborators amassed a formidable body of experimental findings.

He also caught the public eye with his ideas about how such findings could be put to use by society. In doing so, he drew intense criticism (and misunderstanding) from many quarters. Partly as a result of this, he is probably the experimental psychologist whose name is most familiar to the general public.

Burrhus F. Skinner (1904-90) was born in Susquehanna, Pennsylvania. After graduating from Hamilton College, Skinner decided to become a writer. But he wrote little. Moving to New York City, where he worked as a bookstore clerk, he came across the writings of Pavlov and Watson and was intrigued by them. So, to learn more, he enrolled in the Psychology Department of Harvard University. At Harvard he fell in with a physiologist, William Crozier, who was interested in studying the behavior of "the animal as a whole," as contrasted with the reflexes and conditioned reflexes of physiologists such as Pavlov. So Skinner began a program of experimental research that he never abandoned. The two departments, psychology and physiology, each assumed that the other was supervising the young student. But labels meant little to Skinner. He was happily studying behavior.

Skinner, like Thorndike, quickly became convinced of the great power that reward, or reinforcement, can exert on behavior. More or less by accident, he invented the *Skinner box* (though he himself never called it that, preferring the term *operant chamber*). This was a small enclosure in which there was a response to be made (a lever for a rat to press, or a disk mounted on the wall for a pigeon to peck), and a means of delivering a reinforcement (a bit of food, a sip of water, or anything else for which his animal would work). The reward having been delivered, the rat or pigeon was free to respond again. In this, the situation was a great improvement on Thorndike's. After Thorndike's cat had escaped its "problem box," it had to be caught and placed back in it again. Not so for Skinner. After reinforcement, the animal remained where it was, and Skinner could collect *his* reward of not having to catch and replace it (Skinner, 1956).

He also invented a mechanical device for automatically recording fine differences in the rate of response. Indeed, he was one of the pioneers of automation in behavioral research: responses could be detected, recorded, and followed up with reinforcements, all by automatic apparatus.

(Perhaps this is the place to note that after Skinner's first daughter was born, he, an enthusiastic gadgeteer, built a special crib that enhanced both her comfort and that of her parents. He made the mistake of sending an article about this crib to a popular magazine, which titled its story "Baby in a Box." The urban legend grew up that he raised his daughter in a Skinner box, and that she later became insane or committed suicide or both. None of this is true. The "box" was simply an improved crib, and Skinner's daughter is a successful artist who lives in England with her husband.)

Rather than focusing upon the things that happen *before* a response occurs, as with Pavlov's conditioned reflexes, Skinner found (as had Thorndike) that the events *following* the response had a great influence on its subsequent rate of occurrence. If food was presented to a hungry rat after it had pressed a lever, the rate of lever pressing would increase. This he called *operant conditioning*: if a response (the operant) is followed by a reinforcing stimulus, response strength is increased. And food, for a hungry rat, is a reinforcing stimulus. This is not circular. It means that an operant and a reinforcer are jointly defined by and experimental outcome. If we

see this experimental outcome, then we say (a) that the lever press is an operant, and (b) that food is a reinforcing stimulus. The two are defined jointly by that outcome.

Other concepts are defined behaviorally in similar ways. If, for example, an animal is reinforced for lever pressing only if a light is on, and is never reinforced if it is off, then the animal will come to press at a much higher rate when the light is on than when it is off. This is *discrimination*. It is important to understand that for Skinner, that experimental finding is not a reflection of, or an indication of, a process of discrimination going on somewhere inside the animal. It *is* discrimination. The term is used only to describe the behavior, and not to refer to any underlying process that cannot be directly observed or described.

In his later work, Skinner found that the pigeon had certain advantages over the rat as an experimental subject. Pigeons are not good at pressing levers, but they are quite good at pecking a little disk mounted on the wall of the box, known as a *pecking key* by analogy to a telegraph key. Skinner began a series of investigations of pigeon behavior, focusing on the effects of various schedules of reinforcement (described later). His classic book *Schedules of Reinforcement*, describing this work, was published with Charles B. Ferster (Ferster & Skinner, 1957).

A *schedule of reinforcement* is one in which reinforcement is made available to the subject or participant only some of the time, according to certain rules; these rules define the schedule. And it turns out that different schedules give rise to characteristically different patterns of operant behavior. The simpler ones are as follows:

*Fixed ratio.* Every  $n$ th response is reinforced. Thus, for instance, every 10th response the animal makes may be reinforced; that would be FR 10. After receiving a reinforcement, the animal must respond 10 times more to obtain the next reinforcement. The ratio, in other words, is the ratio of responses to reinforcements. On such a schedule, the animal will typically pause after each reinforcement, and then run off the next series of responses at a high rate (the “break-and-burst” pattern).

*Fixed interval.* A reinforcement becomes available after a fixed period of time (the “fixed interval”) following the previous reinforcement. Thus with FI 10, after a reinforcement, no further reinforcement is available until 10 minutes have passed. The next response after that is reinforced. The reinforcement is not delivered automatically; the animal still has to make the response in order to receive it. On an FI schedule, the animal will come to make only a few responses immediately after reinforcement, but then will respond at a gradually increasing rate until the next reinforcement occurs.

*Variable interval.* In this case, a reinforcement is made available at variable intervals following a reinforcement. This means that reinforcement could become available any time, and there is no cue that tells the rat or pigeon when it is available. On a VI schedule, one will typically see a steady, moderate rate of response throughout the session.

There are other schedules, and they may be combined in various ways. Two things are worth noting about these schedules of reinforcement. First, they exert remarkably powerful control over the behavior of an organism in a controlled situation. The various patterns just described are seen, not in group averages, but in the behavior of individual organisms (rats, mice, monkeys, or humans working for “points” that can be exchanged for something desirable). One can even show the change from one pattern to another within a single experimental session, in a single animal. One can arrange matters, for example, so that the pecking key is sometimes colored red (by a colored Christmas tree light that turns on behind it), and sometimes green. (Pigeons have color vision.) When the key is red, a fixed-ratio schedule is in effect. When it is green, a variable-interval schedule is in effect. Sure enough, as long as the key is red, one sees the break-and-burst fixed-ratio pattern; when it is green, one sees the steady response rate maintained over time. This is known as a *multiple schedule*, and this complex result, too, is seen in individual animals — be they pigeons, rats,

monkeys, or human beings working for points. Such consistent findings surely must mean that the conditions of reinforcement are of very great importance.

Convinced of this, Skinner, while continuing to experiment, wrote a series of books extending the idea to human behavior in society. He wrote a psychology textbook on the theme (Skinner, 1953), a utopian novel (Skinner, 1948; not all critics thought it utopian), and a critique of the concept of free will, which, like Watson, he thought a dangerous superstition (Skinner, 1971). It need hardly be said that the writings were controversial. Skinner was accused of wanting to “condition” a society of mindless automata. But this is a bad misreading. He was only arguing that behavior is controlled by reinforcement anyway, so we might as well arrange matters so that the actions we all agree are desirable are the ones that are reinforced.

As a specific example: It used to be common practice to shower schoolchildren with praise and gold stars just for being there, in an attempt to raise their “self-esteem.” It does seem that self-esteem is *correlated with* achievement, but the evidence is that the self-esteem is the result of achievement, not the cause. To present reinforcement no matter what a child does makes as much sense, to Skinner, as presenting food to a rat from time to time no matter what it does. We will not see much lever pressing.

On the other hand, most writers today feel that Skinner neglected too much in turning his back on cognition. The studies of cognitive maps and the work that came from these studies show that we do need to consider not just the situation, but also what the organism (rat or human) makes of it — *and* that these internal events can be studied. Moreover, the use of external reinforcers can backfire. Even if it is effective, it can undermine the *intrinsic* rewards of creating and exploring — that is, the rewards of performing these activities for their own sake.

That said, we must still acknowledge the very real accomplishments of Skinner’s approach. One pair of authors (Wade & Tavis, 2000, p. 278) gives the following very partial list:

Behaviorists have taught parents to toilet-train their children in only a few sessions. They have taught autistic children who have never before spoken to use a vocabulary of several hundred words. They have trained disturbed and mentally retarded adults to communicate, dress themselves, mingle socially with others, and earn a living. They have taught brain-damaged patients to control inappropriate behavior, focus their attention, and improve their language abilities. And they have helped ordinary folk get rid of such unwanted habits, such as smoking or nail biting, or acquire wanted ones, such as practicing the piano or studying. [References to these studies are given by Wade & Tavis (2000).]

At a meeting of the American Psychological Association 10 days before his death from leukemia, Skinner gave a talk before a crowded auditorium. He then wrote a version of the talk for publication and finished the write-up on August 18, 1990, the day he died.