9. Classical Learning Theory

Give me a dozen healthy infants, well-formed, and my own specified world to bring them up in and I'll guarantee to take anyone at random and train him to become any type of specialist I might select – doctor, lawyer, artist, merchant-chief, and yes, even beggar-man thief, regardless of his talents, penchants, tendencies, abilities, vocations, and race of his ancestors.

–John B. Watson[1]

An experimental analysis shifts the determination of behavior from autonomous man to the environment . . . . But environmental contingencies now take over functions once attributed to autonomous man, and certain questions arise. Is man then "abolished"? Certainly not as a species or as an individual achiever. It is the autonomous inner man who is abolished, and that is a step forward.

–B. F. Skinner[2]

The Behavioristic Paradigm for Learning Theory

The Dominance of Behaviorism in American Psychology

The history of academic psychology in America in the early to mid-twentieth century is largely the story of learning theory, and underlying this emphasis on learning was the paradigm of behaviorism. Psychologists of this period who studied learning processes were mainly concerned with learning through conditioning. They studied both classical conditioning, as formulated by Ivan Pavlov, and operant conditioning, which is closely associated with B. F. Skinner's work. Before defining and elaborating on these two kinds of conditioning, a very brief history of psychology traces some important trends in psychology. In particular, it is interesting to see how psychology became so centered on learning theory, and also on its rather narrow, behavioristic framework for studying the dynamics of learning.

What psychology was in its earliest years, what it became from there, and where it may go next as a field, are all important considerations for putting things in perspective, because psychology as a field has undergone several identity crises in its brief history: Its very definition has changed more than once – and that definition in itself has radically altered what psychologists think about and the phenomena that they study.

A Very Brief History of Early Psychology

In its early days as a scientific discipline, psychologists in the tradition of Wilhelm Wundt began measuring human behavior in laboratories. Wundt founded the first major experimental psychology laboratory in 1879, in Leipzig, Germany. This is considered a landmark date in psychology, but even before this, in 1862, Wundt devised an instrument he called a "thought meter" (Diamond, 1980; see Fig. 9.1). Robert Gregory described this contraption as a device that "was a calibrated pendulum with needles sticking off from each side. The pendulum would swing back and forth, striking bells with the needles. The observer's task was to take note of the position of the pendulum when the bell sounded . . . Wundt thought the difference between the observed pendulum position and the actual position would provide a means of determining the swiftness of thought of the observer (Gregory, 2000, p. 5)." Although Wundt was concerned with the search for general laws in psychology, he also acknowledged that individual differences could be found in sensation and perception. Gregory notes that psychologists at the time, which he called the "brass instruments" error (because many lab instruments such as the thought meter were made of brass), mistook the ability to accurately detect the simultaneity of these two events as a measure of intelligence. In a similar way, most other so-called brass instrument devices measured reaction time in some form.

The mid to late nineteenth century was a productive era for psychological science in many areas. Gustave Fechner, working in an area called ***psychophysics***, was studying human sensation – how varying the intensity of physical stimuli such as sound, light, and skin pressure, affected detection of sensory input (sensory threshold detection). For instance, psychophisicists study how

many decibels musical note must be increased before a subject perceived the increase (the "just noticeable difference," or "jnd" unit). During this same era, Hermann Ebbinghaus pioneered techniques on studying recall in memory using lists of "nonsense syllables," which were three letter words which included a vowel sandwiched between two consonants (e.g., DAK, BUP, NOP, KEZ). Because both the psychophysicists and those studying memory and forgetting could map out mathematical curves and functions, psychologists began to feel that their field was moving away from the realm of philosophy, and becoming a respectable physical science in its own right.

In England, Sir Francis Galton was busy studying individual differences in numerous areas of human functioning, including measures of reaction time, the aesthetics of beauty, physical differences among people (such as height and weight), personality, intelligence, and so on. Galton believed that *all* human traits on which people differed could be measured objectively. Galton was considered the father of mental testing.

Francis Galton: Genius, or Dilettante?

Wundt was fortunate in one sense – German universities began to recognize the importance of the new field of psychology as a scientific discipline. But in England, universities did not support psychology. How, then, did Galton manage?

Galton was not a psychologist, but a man of many interests. Morton Hunt described him as "A genuine polymath, he was a successful inventor, award-winning geographer, authoritative travel writer, meteorologist, developer of the first workable system of identifying fingerprints, pioneer in the use of twin studies to tease apart the influence of heredity and environment, and inventor of correlational analysis, one of the most valuable tools of psychology and other sciences" (pp. 2209-210). [Although Karl Person worked out the mathematical details of correlation, Galton originated the general concept.] He devised a number of scorable tests of human abilities, including intelligence, making him the

"father of mental testing." Galton attempted to measure every kind of human attribute, from strength to intelligence – even psychological states such as boredom, and he went so far as to propose quantifying the power of prayer. Yet his visage was narrow when viewed from today's perspective. The grandson of scientist-philosopher Erasmus Darwin, he was Charles Darwin's cousin. Perhaps, then, it is not surprising that he came to believe that genius ran in families. Lacking support from government and university, but with a strong intellectual background and family wealth, Galton pursued his interests on his own.

His belief in the inheritance of most psychological and physical traits, including intelligence, must have made him feel that he, himself, was one of the elites. He was a founder of the eugenics movement which advocated social engineering based on hereditary endowment. Those with better genetic endowment – the more intelligent – should be allowed to have bigger families; those at the lower end of the scale should perhaps not be allowed to reproduce at all! His ideas were also decidedly racist: He believed black Africans to be inferior in mental ability to white Europeans, for example. His notions about eugenics were misused by misguided researchers later on. For example, in testing immigrants to the United States at Ellis Island in the early twentieth century, central and eastern Europeans, such as Italians and Poles, as well as Jewish immigrants, were "found" to be mentally deficient as a group (although mainly they couldn't pass the tests because of poor English language skills; Gould, 1981). Again, the presumption was that these lower scores were due to the genetic inferiority of these peoples rather than to differences in education or culture.

Shortly after the turn of the century, Alfred Binet and Théodore Simon (1905) created the first standardized intelligence test in France. French psychologists Janet and Charcot were studying hypnosis as a treatment for hysteria, works that influenced the great Viennese psychoanalyst, Sigmund Freud.

In America, William Bradford Titchenor and James McKeen Cattell, both former students of Wundt, became established in American universities, Titchenor at Cornell, and Cattell at Columbia. Cattell was the first psychologist to use the term "mental testing" (Gregory, 2000). He became very interested in studying individual differences in reaction times for many kinds of mental tasks. By contrast, Titchenor was not interested in the mental testing tradition of mapping out individual differences in various abilities, but rather emphasized the experimental study mental activity. More in the spirit of Wundt, Titchenor was searching for general laws of psychology. But his focus was on mental processes, not external behavior. Much later on, Lee Cronbach (1950) would refer to these approaches as "The Two Disciplines of Scientific Psychology" (i.e., the study of individual differences, per the mental testing tradition, and general processes, per the experimental tradition).

Titchenor's psychology became known as ***structuralism*** because he attempted to analyze the structure of consciousness using a technique known as ***introspection***.. This method required that highly trained observers report on their mental activities: Sensations, feelings, images, and the like. Unfortunately, this method proved fruitless; it was simply impossible for people to make meaningful scientific advances by studying the workings of the mind in this manner. However, another Amercian psychologist, William James, viewed consciousness differently. James' approach, based on the Darwinian idea of adaptation, was called ***functionalism***. James believed that consciousness, including perception, thought, and feelings, had all evolved to serve in the survival of the human species, and therefore, that all must in this sense be functional. Consciousness for James was like a stream or flow of thoughts and images, which he called the ***stream of consciousness***; conceptually it was nothing like a static structure whose content could be captured and analyzed at some particular time point. James was a highly educated and very well-rounded man, who was one of the developers of the philosophy of pragmatism. He was also the first major psychologist to study the psychology of the self, including the self-concept.

Introspection and Structuralism: How Did Titchenor's System Actually Work?[3]

Titchenor wanted to study conscious experience objectively. To do so, he trained others to be diligent observers. To learn how one perceived an object, say a desk, the observer attempted to objectively describe the object as mentally experienced. To call it a "desk" was considered a "stimulus error," because it was based on one's prior knowledge of the object. Instead, the observer would describe things like the shape, the intensity of the color and so on.

The structuralists were interested in three aspects of conscious experience: sensation, images, and affection (emotional experiences), but the major effort was spent on studying sensation. Sensations were described in terms of qualities (e.g., hardness; coldness), intensity (e.g., degree of loudness or redness), and duration (how long the sensation lasts). In addition, observers had to report on the clarity of the conscious experience.

If all this sound odd, consider that the observer's tasks were not particularly easy to carry out. Although structuralism did not survive as a school of psychology, Titchenor did at least make a strong impression on the field with his insistence on objectivity and on the use of the experimental methods in psychology.

Conditioned Learning: Thorndike and Pavlov. Edward L. Thorndike, a student of both James at Harvard and Cattell at Columbia, was an experimental psychologist with an interest in animal learning. He was obviously influenced by functionalism, and the adaptive nature of behavior in particular. Thorndike was also influenced by Locke's associationism because he believed that learning of complex behaviors was built upon a foundation of simpler learned behaviors, and that the building blocks of behavior were the connections of responses with reinforcements (as discussed below). Thornkike as well as the behaviorists who followed him in this tradition also believed that studying the way in which animals learn was considered an acceptable way to

discover how humans learn: The principles of learning ought to be the same in higher animals because of our common evolutionary foundations. This follows from C. Lloyd Morgan's famous canon, **"**In no case is an animal activity to be interpreted in terms of higher psychological processes, if it can be fairly interpreted in terms of processes which stand lower in the scale of psychological evolution and development" (Morgan, 1903, p. 59). This assumption justified the use of comparative (animal) studies, especially because in studies of conditioned learning and forgetting, human and animal learning curves have essentially the same shape (see Fig. 9.2). Indeed, as strange as it may seem today, many psychologists deemed it unnecessary to consider the role of human thought in formulating the basic principles of learning considered by the theorists in this particular era of psychological history[4].

Thorndike studied ***trial-and-error learning*** in animals. Placing cats into box-like cages, he observed that their seemingly random behavior eventually led them to discover a means of escape. Escaping from Thorndike's boxes required a complex series of movements in which the cat accidentally unlatched a locking mechanism. After a number of trials, the cat learned the movements that allowed it to escape, and of course, tended to repeat them every time it was returned to the cage. This perfectly illustrates Thorndike's ***law of effect***, which can be stated in various ways; perhaps in its simplest form it can be said that behavior which is followed by favorable consequences (later called a reinforcement) tends to be repeated, and that which is followed by unfavorable consequences (or punishment) tends not to be repeated. Thorndike believed that all learning was built upon the associations (he preferred the term "connections") made between particular behaviors and the resulting reinforcements. The law of effect became the principle underlying a form of learning called ***instrumental learning***, or later (due to Skinner), ***operant conditioning*** (because the animal or person actively operates on the environment via trial-and-error learning; as opposed to Pavlov's classical conditioning, considered next, in which the organism is essentially passive).

Ivan Pavlov was a Russian physiologist who was interested in the physiology of digestion. In studying salivation in dogs, Pavlov discovered classical conditioning by the vigilance of his observations. He collected saliva in tubes from the salivary glands. In his experiments he notice that dogs salivated not only when food was presented, but even before that, at the mere sight of the food dish, or of the person bringing the food to the animal. Salivation was not only a basic reflexive, biological process, but it could also be a learned response.

Pavlov studied such learning systematically, by isolating dogs, placing them in harnesses, and removing extraneous stimuli (such as handlers with food) that might affect their conditioning. Then he proceeded to introduce stimuli designed to elicit the salvation response, such as a light going on or a bell ringing just before feeding. Just placing food in the mouth without any such stimuli he called the ***unconditioned stimulus (UCS)***, and the resulting salivation he called the ***unconditioned response (UCR)***. A previous neutral stimulus (e.g., ticking metronome, light, or bell) was then introduced and paired with the unconditioned stimulus just prior to the feeding. Pavlov called this the ***conditioned stimulus (CS)***. After a number of trials, the conditioned stimulus itself triggered the salivation, which Pavlov called the conditioned reflex or ***conditioned response (CR)***, as it is better known today.

Classical conditioning can be observed in many ordinary circumstances. People often observe this phenomenon operating in their own pets, when feeding time is preceded by certain rituals, such as opening the food cupboard. Although salivation may not be obvious, the enthusiastic wagging of tails (in the case of dogs), or other signs of excitation are. In other words, the animal has learned to associate this conditioned stimulus (opening bag of cat or dog food, for example) with dinnertime!

If reinforcement is removed (by the experimental psychologist in the lab, or by circumstances in the natural environment), ***extinction*** of the response occurs. In other words, if a conditioned stimulus such as Pavlov's bell, is no longer followed by the presentation of food, the conditioned response disappears after a few trials. But conditioned responses can be quickly relearned if

the reinforcement is reintroduced. This phenomenon is called ***spontaneous recovery***.

Also, in both types of conditioning ***stimulus generalization*** sometimes occurs, in which a broad range of stimuli will evoke the conditioned response. Thus, if the original stimulus in Pavlov's classical conditioning was a bell with a given tone, some dogs may respond to other tones that are much higher, lower, or louder, and not just the original bell tone. The opposite of stimulus generalization is called ***stimulus discrimination***, which refers to the limiting or narrowing of the range of stimuli that will elicit a response. Pavlov's dogs, for example, could be conditioned to salivate at a tone of a particular pitch – but not a different pitch – simply by rewarding only the first; the dog soon learns which will be rewarded!

Thorndike and Pavlov: Their Similarities and Differences

Is it true that great minds think alike? In his classic *History of Experimental Psychology*, Edwin Boring (1950) begins with his reflections on ***zeitgeist*** – the "habits of thought that pertain to any region and period (p. 5)." Another translation of *zeitgeist* is simply the "spirit of the time." Do people make history, or do the times themselves call forth great minds? Perhaps the era of the late nineteenth and very early twentieth century were ripe for the young science of psychology for the insights of Pavlov and Thorndike – if neither man had done his research, would other brilliant minds have stepped forth with ideas similar to theirs on learning and conditioning? Perhaps these were ideas whose time had come!

Both Pavlov's classical and Thorndike's instrumental (or operant) conditioning depend on reinforcement (or reward; or as Thorndike put it, a "favorable consequence"). Pavlov's "law of reinforcement," as it is sometimes called, is not very different from Thorndike's law of effect. But Thorndike (1898) published his ideas first, in dissertation form, about four years ahead of Pavlov

(Woodworth, 1948). According to Woodworth, "It took many years before the identity of these two laws was recognized. The two discoveries were as independent as possible. Thorndike . . . was following up the evolutionary interest in animal intelligence. Pavlov . . . came upon the 'conditioned reflex' . . . in the course of his investigations of digestion . . . (1948, p. 50)." Pavlov received the Nobel Prize in 1904 for his research on digestion[5]. Later, on learning of Thorndike's results, Pavlov acknowledged Thorndike's priority. But Pavlov always believed that physiology and not psychology (then largely considered the study of mental processes, per Titchenor's structuralism) was the key to understanding behavior (Woodworth, 1948). Thorndike's doctoral dissertation remains the most influential of any ever produced in psychology (Chance, 1999; Myers, 2004).

Yet despite the commonality of reward in both systems, classical and operant conditioning represent two somewhat different kinds of learning processes.

Watson's Behaviorism

In the discussion of the history of psychology to this point, it should be obvious that the subject matter of this field included the studies of both mental processes (per Titchenor's structuralism as well as James and the functionalists) *as well as* behavior (as seen in Pavlov's classical conditioning and the animal learning theories of Thorndike). John B. Watson, however, wished to narrow the definition of psychology to *only* the study of observable behavior. Watson was quite strongly influenced by Pavlov's studies of conditioning. Pavlov disdained psychology because he did not believe that there could be a true science based on the study of mental activity. Titchenor's structuralism, with its fruitless method of introspection, was discouraging enough to psychologists of the time, but Watson also felt that functionalism of James and others was a dead-end street for psychologists. For Watson saw in the study of consciousness a kind of dualistic nonsense whereby mind

and body were seen as separable, interacting entities (Heidbreder, 1933). Thus for Watson, there was only one reality, which was that was what could be observed directly and objectively; namely, overt behavior.

Watson's concern with behavior also led him to a rather extreme environmentalist's position: What a person was, or who he or she could become, depended almost solely on what was learned in life, or even more narrowly, on their conditioning. Watson's bold proclamation (quoted at beginning of this chapter) was that he could mold any "normal" child into any type of person one could imagine, ranging from professional to artist, or from genius to fool. The one caveat in this statement seems to be that the infant he would condition[6] should be "well-formed," presumably meaning that the child had no *major* physical nor mental defects (e.g., was not retarded). With this one exception, then, heredity played no role for Watson; including one's intellectual capacities, but excluding certain very extreme cases. By implication, of course, *one's intelligence is therefore almost entirely a function of one's experience* (contrast this with the notion of heritablity of intelligence, discussed in Chapter 4).

Following Pavlov in particular, Watson used classical conditioning as his model for a psychology based primarily upon the principles of learning. Looking to Morgan's canon, he also believed that the laws of behavior could understood though comparative psychology, through the laboratory study of animals. Research with animals also had the advantage of laboratory controlled environments, which could not be so readily imposed upon human subjects.

Watson is also known for his famous (or infamous) "Little Albert" experiment, conducted with his associate, a graduate student named Rosalie Rayner (Watson & Rayner, 1920). These two researchers wanted to demonstrate the effectiveness of Pavlovian conditioning on humans; specifically, they conditioned a kind of fear response in an infant (Albert) who was only nine months old at the time. Albert was initially unafraid of a tame white rat (or of other furry animals and objects) at the beginning of the experiment. Watson and Rayner used an unconditioned stimulus – a loud clang of a steel bar struck with a hammer –

introduced along with the white rat. They were quite successful; after only a few pairings over a couple of weeks time, poor Albert demonstrated a very strong fear reaction at the sight of the rat. But he also became fearful of other furry animals and fuzzy objects, even a Santa Claus mask. Albert was, fortunately or unfortunately, adopted shortly after this experiment, so the experimenters never had a chance to extinguish this fear response.

Interestingly, another associate of Watson's, Mary Cover Jones, applied classical conditioning to another young boy – Peter, aged three – who had acquired fears of furry animals and furry objects through the course of experience. Jones (1924) pioneered a therapeutic technique that later came to be known as ***systematic desensitization*** in which fears or phobias are treated by a kind of ***exposure therapy***. In this case, a caged rabbit was placed in the same room as Peter, but at quite a distance away. Each day the rabbit cage was moved closer and closer to the child. To shorten the story, eventually Peter was able to not only tolerate the presence of the rabbit, but also was able to touch and pet it. Additionally, Peter lost his more general fear of furry objects (another case of stimulus generalization). But it was not until much later that the technique of systematic desensitization became widely used as a method of treating phobias. This method was more fully exploited by Joseph Wolpe (e.g., Wolpe, 1958). (Wolpe combined incremental degrees of exposure with relaxation and anxiety reduction methods.)

Watson's Success on Madison Avenue

Watson's personal (as well as his professional) life were certainly interesting. A married man, he had an affair with Rayner, who at the time was a single graduate student. When this affair became public, Watson and his wife divorced. He later married Rayner, but he was dismissed from his academic position as a result of the scandal.

Watson joined the J. Walter Thompson advertising agency where he began a new and very successful advertising executive.

He was known for his use of psychological principles in creating advertising campaigns. Earlier in his career, Watson (1919) had identified three basic emotions that he believed were innate: fear, rage, and love. He used appeals to these, as well as to sex (à la Freud), in his ads. In other words, he wanted to either scare the heck out of people, make them mad, appeal to their best nature, or catch their attention with sexy advertisements. In classical conditioning terms, the product that he wanted to sell became associated with these basic, innate human tendencies. These methods worked, and of course, are still widely used today. If we worry about bad breath or perspiration stains, or love the fresh feel and softness of a brand of tissue paper – or if men want to drive the sports car endorsed by a beautiful model – remember that it was Watson who pioneered such ideas[7].

Watson on Parenting

Watson (1924) believed in a no-nonsense approach to parenting. Parents should put the infant on the parent's schedule, not the other way around. Neither did he believe in excessive displays of emotions toward the child; hugging, kissing, fussing, cuddling – these were all to be avoided. Don't be "mawkish and sentimental" with your children, Watson advised. He also wrote articles in popular magazines urging parents to follow such practices.

Watson's actual influence on parenting practices is difficult to gauge, but probably other writers such as "Dr. Spock" (1946) and Arnold Gesell (e.g., 1943)[8] were both more moderate in their views, and also more influential with parents.

B. F. Skinner's Operant Conditioning

Skinner like Watson believed that the purpose of scientific psychology was the prediction and control of behavior. Like Watson Skinner believed that psychology needed to be purged of mentalistic concepts, internal states (or "explanatory fictions," in Skinner's words), and considerations of psychological histories,

heredity, or instincts. And also like Watson, Skinner was an articulate spokesman for the behaviorist cause. They differed in some respects, however. Whereas Watson worked more with classical (Pavlovian) conditioning, Skinner – though he recognized that classical conditioning had its place – stressed mainly the importance of operant (or instrumental) conditioning. If Watson's great influence was Pavlov, Skinner's was Thorndike. But between Watson and Skinner, Skinner was by far the better scientist.

Operant conditioning is thus concerned mainly with the influence of environment on behavior. The organism *operates* on the environment (by seemingly random or trial and error behavior). Behavior that is reinforced ("rewarded") tends to be repeated, so if the scientist wishes to understand behavior he/she must study the environmental conditions that foster the behavior – in particular the circumstances that immediately precede it. Thus it is the environment controls behavior; or to put it slightly more accurately, *behavior is controlled by its consequences*.

Operant conditioning differs from classical conditioning in that the latter assumes a certain stimulus (UCS or CS) that is associated with a given response (UCR or CR). This Pavlovian model is sometimes known as S – R psychology (for stimulus – response). Skinner referred to this as *respondent* conditioning because the organism responds to the presence of a stimulus. In contrast, with operant conditioning there need be no specific stimulus that is associated with a response; rather, the response is controlled by what follows, namely the reinforcement.

Skinner believed that most everyday behaviors can be explained by operant rather than by respondent conditioning. While it is true that the sight of a box of chocolates might cause one to literally salivate, or that the scent of night-blooming jasmine might elicit a pleasant, nostalgic memory, most of what people (or animals) do does not depend on such specific stimuli – rather, behavior is much more a function of past reinforcements. Operant behavior for most of us is likely to include rising at a certain time on weekdays, preparing for work or school, and going about one's business in an ordinary way throughout the day. All of our routines are mainly shaped by past consequences, which include both reinforcements and punishments.

Skinner's learning paradigm is best illustrated by his use of the ***Skinner box***: A literal box housing the animal (typically rat or pigeon) with a water spout for drinking and a lever that the animal learns to press (or peck as the case may be). In response to the bar pressing the animal is reinforced by the automatic release of a food pellet (or perhaps a piece of corn). In a simple learning experiment the animal (e.g., rat) learns to press a bar because it is reinforced for this behavior with the release of the food. After many such trials, when the behavior becomes established, learning is said to have occurred, as with Thorndike's cats. But to Skinner this learning is nothing more than the lawful relation of response to reinforcement; there is no necessity to posit any sort of motivation or need, or perception of the situation by the animal.

However Skinner did go so far as to state that deprivation of food or water created a state of increased activity which in turn could lead to quicker learning. He might even use the term "hunger," though not as a description of an internal state, but rather as operationally defined as hours of food deprivation.

Basic Principles of Operant Conditioning

The phenomena of extinction, spontaneous recovery, and stimulus generalization and discrimination occur in operant conditioning just as they do in classical conditioning. In the case of the rat in the Skinner box, extinction of the bar pressing behavior occurs when the animal ceases to be receive the reinforcement (food) over many trials. But relearning is quicker (spontaneous recovery) when the reinforcement is reintroduced.

A pigeon can learn to peck at a colored disk for which the bird is reinforced. Suppose the original disk is red in color. If the experimenter next introduces a disk of a different color and the pigeon continues to peck it, this is a kind of stimulus generalization; but if only rewarded for pecking a disk that is red, the pigeon soon learns that more specific behavior (stimulus discrimination).

Types of Reinforcement and Punishment

For Skinner a ***reinforcement*** is anything that increases the probability of the occurrence of a behavior (or in his terms, of an

operant response being emitted). ***Primary reinforcers*** satisfy basic biological needs, such as food, water, and sex. ***Secondary or conditioned reinforcers*** are learned. Examples of the latter include many social needs, such as a child being praised, hugged, or patted for good behavior. Money, status, and property are typical secondary reinforcers for adults.

Positive reinforcement can be primary or secondary; positive reinforcement occurs when a person or animal emits a response (acts in a certain way) such that the action results in the increased probability of that behavior being repeated. (Recall that Thorndike used the term *reward* rather than reinforcement, defining it as "a satisfying state." Skinner, however, found this term too mentalistic.) Examples of positive reinforcement are quite easy to come by: If a student studies hard her positive reinforcement is a good grade, or if a child does his chores on time he gets an advance on his allowance.

Contrary to what many people believe, negative reinforcement does not pertain to behavior that leads to negative consequences: That state of affairs is known simply as ***punishment***. In punishment the performance of a certain behavior reduces the probability of that behavior being emitted in the future. Examples of punishment are also easy to think of, such as when a football team is penalized a certain number of yards on the field when a player is off-sides, or when a teen is grounded for staying out too late. In contrast, ***negative reinforcement*** occurs when performance of a certain action results an aversive outcome being avoided or removed. A good example is taking a pain medication (e.g., an aspirin) to make a headache go away: The action is swallowing the pill, the positive result (reinforcement) is the elimination of the pain. Note that it is the *removal* of the aversive consequence which results in (using Thorndike term), a satisfactory state of affairs; but again Skinner would avoid such a value-laden term.

Like the philosopher John Locke (per Chapter 2), Skinner believed that the most effective way to control or shape behavior was through reinforcement, especially positive reinforcement. For Skinner aversive conditioning or punishment should be reserved for short-term, temporary use, and only then when no other effective method is available. For example, it is not easy to teach a

young child not to dash into the street, a behavior which is extremely dangerous. A parent might resort to a quick swat to the behind to discourage this behavior (the punishment) rather than attempt to explain to the child why this behavior is dangerous when such an explanation is beyond the child's level of comprehension.

Like Locke, Skinner recognized that punishment has many disadvantages. Although punishment suppresses behavior the cessation of the undesired behavior may just be temporary. For example, the child who is punished for aggressive behavior (hitting, biting, and so on) may continue to exhibit such behavior toward other children when adults are not present. Locke also noted that harsh punishments can result in excessive shame resulting in what today would be called low self-esteem.

Schedules of Reinforcement

A pigeon may be rewarded for pecking at a colored disk, but only after eliciting a certain number of responses (e.g., after pecking ten times). Skinner used various ***schedules of reinforcement*** to see which led to stronger or more rapid learning. This example illustrates a ***fixed ratio*** schedule, in which the bird is reinforced only after a given number of responses have occurred. By contrast, a ***fixed interval*** schedule is one in which the pigeon is rewarded for pecking, but only after a specified *time interval* (say 20 seconds) has elapsed. In both cases reinforcement is ***intermittent*** rather than continuous and immediate. As one might reasonably guess, learning is faster when the reinforcement is constant and immediate; however, it is generally stronger with intermittent reinforcement, and extinction is also slower in that case.

In both the fixed ratio and fixed interval schedules there is a drop-off in responding right after the reward. It is not that the animal "knows" that it isn't going to get rewarded again right away, but rather that it has simply learned this association between delay of behavior and reinforcement. But if the reinforcement schedule is made variable this kind of drop-off can be avoided.

Variability in the schedules of reinforcement leads to two other types. In a ***variable ratio*** schedule the animal or person is rewarded

after so many responses are given on the average, but with a certain degree of variability around that average. For example, the pigeon is rewarded after every 10 pecks on the average, implying that sometimes the reward will follow 8 attempts, sometimes 12 or 15, and so on. In the ***variable interval*** schedule the reinforcement likewise comes after a certain average length of time – but not exactly on that time.

Common examples of schedules of reinforcement that people experience are shown below. (Remember that ratio always refers to the number of responses, interval refers to time).

- **Fixed ratio:** A young person works in the garment industry and is paid piecemeal, for every 100 dresses stitched.
- **Fixed interval:** A journeyman carpenter gets paid a fixed amount for each hour worked.
- **Variable ratio:** A slot machine pays off, on the average, after 20 attempts.
- **Variable interval:** A person fishing makes his or her catch only after an indefinite time interval transpires (if at all) yet keeps at this effort for several hours.

Shaping and Modifying Behavior

Skinner advocated the control of behavior. He believed that for the betterment of society, scientists or those policy makers informed by scientific findings, could help make the world a better place by implementing appropriate behavior controls. Skinner might thus seem something of an idealist in his lofty goals for a better, utopian society. But he was following a tradition of American socio-political progressivism that was popular in the early twentieth century, as "[b]oth the Progressives and the social scientists believed that science should serve the good of society, where good was defined primarily in terms of material comforts and success. Both groups also believed that it was possible to develop social technologies to shape human beings to serve the ends of society, as defined by an elite with access to objective knowledge of the ultimate purposes of society" (Mills, 1998, p. 19). In defense of this position Skinner wrote a novel, *Walden Two*

(Skinner, 1948), which describe his ideal society. That society was based on [***to be completed later***].

Shaping involves teaching complex behaviors through operant conditioning – by reinforcing successive approximations, first by rewarding gross approximations, then later by rewarding only those that are progressively closer to the final desired behavior. Skinner used shaping to teach skills to pigeons that seemed amazing, considering this bird's relatively small brain cortex – but Skinner would be the first to note that thinking was not at all a part of the process. As an example, Skinner conditioned his pigeons to make a 180 degree turn when a "TURN" sign appeared above their feeding apparatus. This can be done by first reinforcing a partial turn (say 30 degrees) when (and only when) the sign is flashed. Later the behavior is rewarded only when the pigeon extends the turn a few degrees more, and so on, until the complete turn is negotiated and the bird's behavior is firmly shaped. To the naïve observe, the pigeon appears to be reading the sign!

The application of behavioral techniques to therapy – particularly operant conditioning – is called ***behavior modification***. As with other forms of therapy, behavior modification attempts to help people with psychological disorders, such as phobias or the acting out behaviors that are sometimes seen in mental patients. But rather than changing people's attitudes about themselves directly (as in cognitive therapy) or looking into a person's medical and psychological history, the behavior therapist concentrates solely on observable behavior. The idea is to reinforce normal, healthy behaviors (e.g., calmness during crisis) and extinguish unhealthy ones (e.g., fear of flying).

One of the more interesting applications of behavior modification was in mental institutions where patients were rewarded for pro-social or helping behaviors (helping themselves or others) by awarding them tokens (plastic chits, similar to coins) whenever they performed according to expectation. Token economies were tried and found to be successful in the 1950s, before the widespread use of psychotropic drugs. As an example, a depressed patient might be rewarded for simply being active: Rising early from bed, making his/her own bed, and so forth. After collecting a number of tokens, these are redeemable for more

tangible rewards, such as sweets or gift items. As advocated by Skinner, positive reinforcement is used the most, punishments only as a last resort. Behavior therapists refer to this system as a ***token economy***. These procedures were discontinued, however, because of the ethical issues that they raised concerning basic patient rights (Comer, 2005). In other words, the courts ruled that these patients were entitled to certain privileges that shouldn't have to be earned by acting in conformity with the dictates of the clinicians.

Evaluating the Behavioral Approach to Learning and Development

Early psychologists working in the tradition of learning theory from the time of Thorndike contributed enormously to the understanding of human and animal learning. But ultimately not all of the important issues in psychology could be understood through the study of overt behavior only. Behaviorism reached its zenith somewhere in the middle of the twentieth century. By the 1960s psychologists began to run out of interesting phenomena to study by observing rats in mazes or Skinner boxes. The field of psychology was getting stale. In Robert Ornstein's (1976, p.22) accounting of his first experience of a psychology class he states:

> I arrived at my psychology class with my impossibly idealistic freshman expectations: with the perspective of evolution integrated, after all, and with the scope provided by [William] James, psychology had had seventy years or so to apply the various developments in hard science to a complete science of man.
>
> When we were all seated, our professor arose. I recall . . . his appearance: a man in a gray-brown suit, quite overweight, with a large nose, and short sandy hair combed forward. My very thought was that he looked like a giant rat. [He] began, "I know that many of you are here because of an interest in your experience, a desire to find out what goes on in your thoughts, to understand abnormal consciousness and schizophrenia, and because of your interest in learning about ways in which your mind can operate.

> "I want to tell you that psychology as you will learn it does not consider those questions as proper subjects of scientific evidence, and how a fact becomes worthy of science."
>
> Save for the first part of his invocation, I would have been sure I had simply made a mistake: Had I entered the wrong room perhaps . . . or the wrong department? Perhaps I had entered Statistics 347B, or Introduction to Methodological Analysis 665F. For the remainder of the semester, we studied rats and taught them to do tricks which they did not want to learn and which we did not care to teach. And, gradually, my impression of my professor deepened: academic psychology was a discipline fascinated with its technical achievement, which had lost its primary focus, and was content to treat Man as if he were a Giant Rat.

If psychology went wrong during this era, where did it begin to lose its direction? Not with Thorndike – though his contribution to learning theory was enormous and entirely original (Skinner built his operant conditioning on Thorndike's foundation). But Thorndike did not consider himself to be a strict behaviorist. His career following his early experiments with trial and error learning took many different and creative pathways.

It was Watson who initially steered the field of psychology into the path of strict behaviorism, but Skinner who picked up the theme in his classic book *The Behavior or Organisms* (Skinner, 1938). Skinner was a more eloquent spokesman for behaviorism than Watson and was also a superior scientist. By then psychology "had surrendered (without regrets) the mind to philosophy, the body to biology, and personality to the clinicians" (Robinson, 1995, p. 347).

The story of how psychology regained these lost domains is told in the next chapter.

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Notes

1. Watson (1924, p. 104).
2. Skinner (1971, pp. 214-215).
3. My source for Titchenor and structuralism is Heidbreder's (1948) classic text.
4. But it should be noted that Thorndike, at this stage of his career, was interested in animal psychology for its own sake. His later worked in many areas of psychology, including intelligence and educational psychology.
5. Unfortunately, no Nobel Prize is given for psychology or for related fields in the social sciences. Psychologists have received Nobel prizes, but mainly because their work touches on other areas, such as medicine or economics. The latest example is Daniel Kahneman, who in 2003, shared a Nobel prize in economics with Vernon L. Smith for their work on human judgment and decision making under conditions of uncertainty.
6. Watson never actually attempted to make good on his boast.
7. It seems to me that Watson overlooked one important potential selling point: Humor. But then he was never known for his sense of humor!
8. At the risk of dating myself, I can recall seeing dusty copies of books by both Spock and Gesell books in my parents' library.