Reinforcement

This article is about the psychological concept. For the construction materials reinforcement, see Rebar. For reinforcement learning in computer science, see Reinforcement learning. For beam stiffening, see Stiffening.

In behavioral psychology, **reinforcement** is a

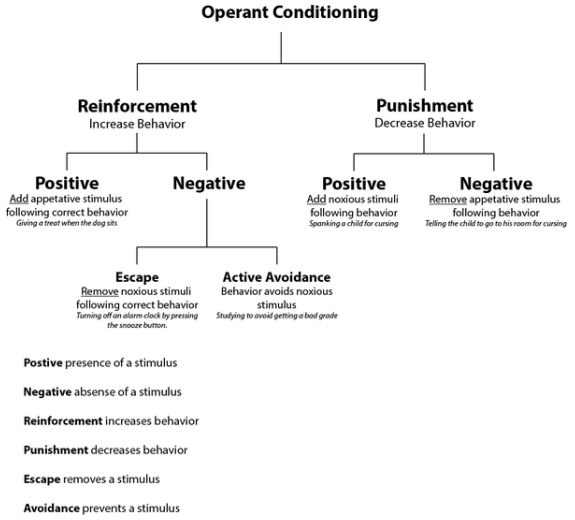


Diagram of operant conditioning

consequence that will strengthen an organism's future behavior whenever that behavior is preceded by a specific antecedent stimulus. This strengthening effect may be measured as a higher frequency of behavior (e.g., pulling a lever more frequently), longer duration (e.g., pulling a lever for longer periods of time), greater magnitude (e.g., pulling a lever with greater force), or shorter latency (e.g., pulling a lever more quickly following the antecedent stimulus).

Although in many cases a reinforcing stimulus is a rewarding stimulus which is "valued" or "liked" by the individual (e.g., money received from a slot machine, the taste of the treat, the euphoria produced by an addictive drug), this is not a requirement. Indeed, reinforcement does not even require an individual to consciously perceive an effect elicited by the stimulus.[1] Furthermore, stimuli that are "rewarding" or "liked" are not always reinforcing: if an individual eats at a fast food restaurant (response) and likes the taste of the food (stimulus), but believes it is bad for their health, they may not eat it again and thus it was not reinforcing in that condition. Thus, reinforcement occurs only if there is an observable strengthening in behavior.

In most cases reinforcement refers to an enhancement of behavior but this term may also refer to an enhancement of memory. One example of this effect is called post-training reinforcement where a stimulus (e.g. food) given shortly after a training session enhances the learning.[2] This stimulus can also be an emotional one. A good example is that many people can explain in detail where they were when they found out the World Trade Center was attacked.[3][4]

Reinforcement is an important part of operant or instrumental conditioning.

1 Introduction

B.F. Skinner was a well-known and influential researcher who articulated many of the theoretical constructs of reinforcement and behaviorism. Skinner defined reinforcers according to the change in response strength (response rate) rather than to more subjective criteria, such as what is pleasurable or valuable to someone. Accordingly, activities, foods or items considered pleasant or enjoyable may not necessarily be reinforcing (because they produce no increase in the response preceding them). Stimuli, settings, and activities only fit the definition of reinforcers if the behavior that immediately precedes the potential reinforcer increases in similar situations in the future; for example, a child who receives a cookie when he or she asks for one. If the frequency of "cookie-requesting behavior" increases, the cookie can be seen as reinforcing "cookie-requesting behavior". If however, "cookie-requesting behavior" does not increase the cookie cannot be considered reinforcing.

The sole criterion that determines if a stimulus is reinforcing is the change in probability of a behavior after administration of that potential reinforcer. Other theories may focus on additional factors such as whether the person expected a behavior to produce a given outcome, but in the behavioral theory, reinforcement is defined by an increased probability of a response.

The study of reinforcement has produced an enormous body of reproducible experimental results. Reinforcement is the central concept and procedure in special education, applied behavior analysis, and the experimental analysis of behavior and is a core concept in some medical and psychopharmacology models, particularly addiction, dependence, and compulsion.

2 Brief history

Laboratory research on reinforcement is usually dated from the work of Edward Thorndike, known for his experiments with cats escaping from puzzle boxes.[8] A number of others continued this research, notably B.F. Skinner, who published his seminal work on the topic in The Behavior of Organisms, in 1938, and elaborated this research in many subsequent publications.[9] Notably Skinner argued that positive reinforcement is superior to punishment in shaping behavior.[10] Though punishment may seem just the opposite of reinforcement, Skinner claimed that they differ immensely, saying that positive reinforcement results in lasting behavioral modification (long-term) whereas punishment changes behavior only temporarily (short-term) and has many detrimental side-effects. A great many researchers subsequently expanded our understanding of reinforcement and challenged some of Skinner's conclusions. For example, Azrin and Holz defined punishment as a "consequence of behavior that reduces the future probability of that behavior,"[11] and some studies have shown that positive reinforcement and punishment are equally effective in modifying behavior. Research on the effects of positive reinforcement, negative reinforcement and punishment continue today as those concepts are fundamental to learning theory and apply to many practical applications of that theory.

3 Operant conditioning

Main article: Operant conditioning

The term *operant conditioning* was introduced by B. F. Skinner to indicate that in his experimental paradigm the organism is free to operate on the environment. In this paradigm the experimenter cannot trigger the desirable response; the experimenter waits for the response to occur (to be emitted by the organism) and then a potential reinforcer is delivered. In the classical conditioning paradigm the experimenter triggers (elicits) the desirable response by presenting a reflex eliciting stimulus, the *Unconditional Stimulus* (UCS), which he pairs (precedes) with a neutral stimulus, the *Conditional Stimulus* (CS).

Reinforcer is a basic term in operant conditioning.

3.1 Reinforcement

Positive reinforcement occurs when a desirable event or stimulus is presented as a consequence of a behavior and the behavior increases.[12]:253 A positive reinforcer is a stimulus event for which the animal will work in order to acquire it. Verbal and Physical reward is very useful positive reinforcement[13]

- Example: Whenever a rat presses a button, it gets a treat. If the rat starts pressing the button more often, the treat serves to positively reinforce this behavior.
- Example: A father gives candy to his daughter when she picks up her toys. If the frequency of picking up the toys increases, the candy is a positive reinforcer (to reinforce the behavior of cleaning up).
- Example: A company enacts a rewards program in which employees earn prizes dependent on the number of items sold. The prizes the employees receive are the positive reinforcement as they increase sales.

Negative reinforcement occurs when the rate of a behavior increases because an aversive event or stimulus is removed or prevented from happening.[12]:253 A negative reinforcer is a stimulus event for which an organism will work in order to terminate, to escape from, to postpone its occurrence. As opposed to positive reinforcement, Verbal and Physical Punishment may apply in negative reinforcement[14]

- Example: A child cleans his or her room, and this behavior is followed by the parent stopping "nagging" or asking the child repeatedly to do so. Here, the nagging serves to negatively reinforce the behavior of cleaning because the child wants to remove that aversive stimulus of nagging.
- Example: A person puts ointment on a bug bite to soothe an itch. If the ointment works, the person will likely increase the usage of the ointment because it resulted in removing the itch, which is the negative reinforcer.
- Example: A company has a policy that if an employee completes their assigned work by Friday, they can have Saturday off. Working Saturday is the negative reinforcer, the employee's productivity will be increased as they avoid experiencing the negative reinforcer.

3.2 Punishment

Positive punishment occurs when a response produces a stimulus and that responses decreases in probability in the future in similar circumstances.

- Example: A mother yells at a child when he or she runs into the street. If the child stops running into the street, the yelling ceases. The yelling acts as positive punishment because the mother presents (adds) an unpleasant stimulus in the form of yelling.

Negative punishment occurs when a response produces the removal of a stimulus and that response decreases in probability in the future in similar circumstances.

- Example: A teenager comes home after curfew and the parents take away a privilege, such as cell phone usage. If the frequency of the child coming home late decreases, the privilege is gradually restored. The removal of the phone is negative punishment because the parents are taking away a pleasant stimulus (the phone) and motivating the child to return home earlier.

Simply put, reinforcers serve to increase behaviors whereas punishers serve to decrease behaviors; thus, positive reinforcers are stimuli that the subject will work to attain, and negative reinforcers are stimuli that the subject will work to be rid of or to end.[15] The table below illustrates the adding and subtracting of stimuli (pleasant or aversive) in relation to reinforcement vs. punishment.

Further ideas and concepts:

- Distinguishing between positive and negative can be difficult and may not always be necessary; focusing on *what* is being removed or added and *how* it is being removed or added will determine the nature of the reinforcement.
- Negative reinforcement is not punishment, Punishment is a tools of Negative reinforcement. The two, as explained above, differ in the increase (negative reinforcement) or decrease (punishment) of the future probability of a response. However, in negative reinforcement, the stimulus is an aversive stimulus, which if presented contingent on a response, may also function as a positive punisher.
- The increase in behavior is independent of (i.e. not related to) whether or not the organism finds the reinforcer to be pleasant or aversive. Example: A child is given detention for acting up in school, but the frequency of the bad behavior increases. Thus, the detention is a reinforcer (could be positive or negative) even if the detention is not a pleasant stimuli, perhaps because the child now feels like a "rebel" or sees it as an opportunity to get out of class.
- Some reinforcement can be simultaneously positive and negative, such as a drug addict taking drugs for the added euphoria (a positive feeling) and eliminating withdrawal symptoms (which would be a negative feeling). Or, in a warm room, a current of external air serves as positive reinforcement because it is pleasantly cool and as negative reinforcement because it removes uncomfortable hot air.
- Reinforcement in the business world is essential in driving productivity. Employees are constantly motivated by the ability to receive a positive stimulus, such as a promotion or a bonus. Employees are also driven by negative reinforcement. This can be seen when employees are offered Saturdays off if they complete the weekly workload by Friday.
- Though negative reinforcement has a positive effect in the short term for a workplace (i.e. encourages a financially beneficial action), over-reliance on a negative reinforcement hinders the ability of workers to act in a creative, engaged way creating growth in the long term.[16]
- Both positive and negative reinforcement *increase* behavior. Most people, especially children, will learn to follow instruction by a mix of positive and negative reinforcement.[12]

3.3 Primary reinforcers

A primary reinforcer, sometimes called an *unconditioned reinforcer*, is a stimulus that does not require pairing to function as a reinforcer and most likely has obtained this function through the evolution and its role in species' survival.[17] Examples of primary reinforcers include sleep, food, air, water, and sex. Some primary reinforcers, such as certain drugs, may mimic the effects of other primary reinforcers. While these primary reinforcers are fairly stable through life and across individuals, the reinforcing value of different primary reinforcers varies due to multiple factors (e.g., genetics, experience). Thus, one person may prefer one type of food while another avoids it. Or one person may eat lots of food while another eats very little. So even though food is a primary reinforcer for both individuals, the value of food as a reinforcer differs between them.

3.4 Secondary reinforcers

A secondary reinforcer, sometimes called a **conditioned reinforcer**, is a stimulus or situation that has acquired its function as a reinforcer after pairing with a stimulus that functions as a reinforcer. This stimulus may be a primary reinforcer or another conditioned reinforcer (such as money). An example of a secondary reinforcer would be the sound from a clicker, as used in clicker training. The sound of the clicker has been associated with praise or treats, and subsequently, the sound of the clicker may function as a reinforcer. Another common example is the sound of people clapping... there is nothing inherently positive about hearing that sound, but we have learned that it is associated with praise and rewards.

When trying to distinguish primary and secondary reinforcers in human examples, use the "caveman test." If the stimulus is something that a caveman would naturally find desirable (e.g., candy) then it is a primary reinforcer. If, on the other hand, the caveman would not react to it (e.g., a dollar bill), it is a secondary reinforcer. As with primary reinforcers, an organism can experience satiation and deprivation with secondary reinforcers.

3.5 Primary vs. Secondary Punishers

The same distinction between primary and secondary can me made for punishers. Pain, loud noises, bright lights, and exclusion are all things that would pass the "caveman test" as an aversive stimulus, and are therefore primary punishers. The sound of someone booing, the wrong-answer buzzer on a game show, and a ticket on your car windshield are all things you have learned to think about as negative.

3.6 Other reinforcement terms

- A generalized reinforcer is a conditioned reinforcer that has obtained the reinforcing function by pairing with many other reinforcers and functions as a reinforcer under a wide-variety of motivating operations. (One example of this is money because it is paired with many other reinforcers).[18]:83
- In reinforcer sampling, a potentially reinforcing but unfamiliar stimulus is presented to an organism without regard to any prior behavior.
- Socially-mediated reinforcement (direct reinforcement) involves the delivery of reinforcement that requires the behavior of another organism.
- The Premack principle is a special case of reinforcement elaborated by David Premack, which states that a highly preferred activity can be used effectively as a reinforcer for a less-preferred activity.[18]:123
- Reinforcement hierarchy is a list of actions, rank-ordering the most desirable to least desirable consequences that may serve as a reinforcer. A reinforcement hierarchy can be used to determine the relative frequency and desirability of different activities, and is often employed when applying the Premack principle.
- Contingent outcomes are more likely to reinforce behavior than non-contingent responses. Contingent outcomes are those directly linked to a causal behavior, such a light turning on being contingent on flipping a switch. Note that contingent outcomes are *not* necessary to demonstrate reinforcement, but perceived contingency may increase learning.
- Contiguous stimuli are stimuli closely associated by time and space with specific behaviors. They reduce the amount of time needed to learn a behavior while increasing its resistance to extinction. Giving a dog a piece of food immediately after sitting is more contiguous with (and therefore more likely to reinforce) the behavior than a several minute delay in food delivery following the behavior.
- Noncontingent reinforcement refers to response-independent delivery of stimuli identified as reinforcers for some behaviors of that organism. However, this typically entails time-based delivery of stimuli identified as maintaining aberrant behavior, which decreases the rate of the target behavior.[19] As no measured behavior is identified as being strengthened, there is controversy surrounding the use of the term noncontingent "reinforcement".[20]

4 Natural and artificial

In his 1967 paper, *Arbitrary and Natural Reinforcement*, Charles Ferster proposed classifying reinforcement into events that increase frequency of an operant as a natural consequence of the behavior itself, and events that are presumed to affect frequency by their requirement of human mediation, such as in a token economy where subjects are "rewarded" for certain behavior with an arbitrary token of a negotiable value. In 1970, Baer and Wolf created a name for the use of natural reinforcers called "behavior traps".[21] A behavior trap requires only a simple response to enter the trap, yet once entered, the trap cannot be resisted in creating general behavior change. It is the use of a behavioral trap that increases a person's repertoire, by exposing them to the naturally occurring reinforcement of that behavior. Behavior traps have four characteristics:

- They are "baited" with virtually irresistible reinforcers that "lure" the student to the trap
- Only a low-effort response already in the repertoire is necessary to enter the trap
- Interrelated contingencies of reinforcement inside the trap motivate the person to acquire, extend, and maintain targeted academic/social skills[22]
- They can remain effective for long periods of time because the person shows few, if any, satiation effects

As can be seen from the above, artificial reinforcement is in fact created to build or develop skills, and to generalize, it is important that either a behavior trap is introduced to "capture" the skill and utilize naturally occurring reinforcement to maintain or increase it. This behavior trap may simply be a social situation that will generally result from a specific behavior once it has met a certain criterion (e.g., if you use edible reinforcers to train a person to say hello and smile at people when they meet them, after that skill has been built up, the natural reinforcer of other people smiling, and having more friendly interactions will naturally reinforce the skill and the edibles can be faded).

5 Intermittent reinforcement; schedules

Much behavior is not reinforced every time it is emitted, and the pattern of intermittent reinforcement strongly affects how fast an operant response is learned, what its rate is at any given time, and how long it continues when reinforcement ceases. The simplest rules controlling reinforcement are continuous reinforcement, where every response is reinforced, and extinction, where no response is reinforced. Between these extremes, more complex "schedules of reinforcement" specify the rules that determine how and when a response will be followed by a reinforcer.

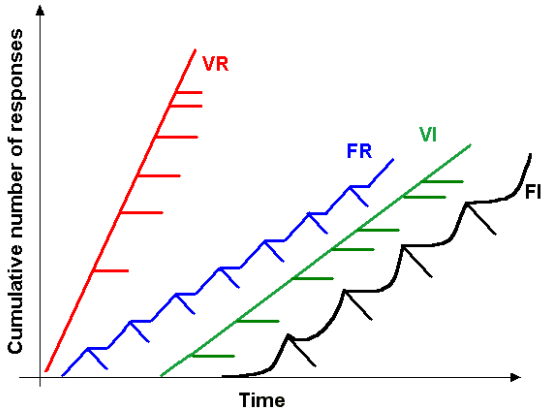
Specific schedules of reinforcement reliably induce specific patterns of response, irrespective of the species being investigated (including humans in some conditions). However, the quantitative properties of behavior under a given schedule depend on the parameters of the schedule, and sometimes on other, non-schedule factors. The orderliness and predictability of behavior under schedules of reinforcement was evidence for B.F. Skinner's claim that by using operant conditioning he could obtain "control over behavior", in a way that rendered the theoretical disputes of contemporary comparative psychology obsolete. The reliability of schedule control supported the idea that a radical behaviorist experimental analysis of behavior could be the foundation for a psychology that did not refer to mental or cognitive processes. The reliability of schedules also led to the development of applied behavior analysis as a means of controlling or altering behavior.

Many of the simpler possibilities, and some of the more complex ones, were investigated at great length by Skinner using pigeons, but new schedules continue to be defined and investigated.

5.1 Simple schedules

- **Ratio schedule** – the reinforcement depends only on the number of responses the organism has performed.
- **Continuous reinforcement (CRF)** – a schedule of reinforcement in which every occurrence of the instrumental response (desired response) is followed by the reinforcer.[18]:86
  - Lab example: each time a rat presses a bar it gets a pellet of food.
  - Real world example: each time a dog defecates outside its owner gives it a treat; each time a person puts $1 in a candy machine and presses the buttons he receives a candy bar.

Simple schedules have a single rule to determine when a single type of reinforcer is delivered for specific response.



A chart demonstrating the different response rate of the four simple schedules of reinforcement, each hatch mark designates a reinforcer being given

- **Fixed ratio** (FR) – schedules deliver reinforcement after every *n*th response.[18]:88
  - Example: FR2" = every second desired response the subject makes is reinforced.
  - Lab example: FR5" = rat's bar-pressing behavior is reinforced with food after every 5 bar-presses in a Skinner box.
  - Real-world example: FR10" = Used car dealer gets a $1000 bonus for each 10 cars sold on the lot.
- **Variable ratio schedule** (VR) – reinforced on average every *n*th response, but not always on the *n*th response.[18]:88
  - Lab example: VR4" = first pellet delivered on 2 bar presses, second pellet delivered on 6 bar presses, third pellet 4 bar presses (2 + 6 + 4 = 12; 12/3= 4 bar presses to receive pellet).
  - Real-world example: slot machines (because, though the probability of hitting the jackpot is constant, the number of lever presses needed to hit the jackpot is variable).
- **Fixed interval** (FI) – reinforced after *n* amount of time.
  - Example: FI1" = reinforcement provided for the first response after 1 second.
  - Lab example: FI15" = rat's bar-pressing behavior is reinforced for the first bar press after 15 seconds passes since the last reinforcement.
  - Real world example: washing machine cycle.
- **Variable interval** (VI) – reinforced on an average of *n* amount of time, but not always exactly *n* amount of time.[18]:89

- Example: VI4" = first pellet delivered after 2 minutes, second delivered after 6 minutes, third is delivered after 4 minutes (2 + 6 + 4 = 12; 12/ 3 = 4). Reinforcement is delivered on the average after 4 minutes.
- Lab example: VI10" = a rat's bar-pressing behavior is reinforced for the first bar press after an average of 10 seconds passes since the last reinforcement.
- Real world example: checking your e-mail or pop quizzes. Going fishing—you might catch a fish after 10 minutes, then have to wait an hour, then have to wait 18 minutes.

Other simple schedules include:

- **Differential reinforcement of incompatible behavior** – Used to reduce a frequent behavior without punishing it by reinforcing an incompatible response. An example would be reinforcing clapping to reduce nose picking.
- **Differential reinforcement of other behavior** (DRO) – Also known as omission training procedures, an instrumental conditioning procedure in which a positive reinforcer is periodically delivered only if the participant does something other than the target response. An example would be reinforcing any hand action other than nose picking.[18]:338
- **Differential reinforcement of low response rate** (DRL) – Used to encourage low rates of responding. It is like an interval schedule, except that premature responses reset the time required between behavior.
  - Lab example: DRL10" = a rat is reinforced for the first response after 10 seconds, but if the rat responds earlier than 10 seconds there is no reinforcement and the rat has to wait 10 seconds from that premature response without another response before bar pressing will lead to reinforcement.
  - Real world example: "If you ask me for a potato chip no more than once every 10 minutes, I will give it to you. If you ask more often, I will give you none."
- **Differential reinforcement of high rate** (DRH) – Used to increase high rates of responding. It is like an interval schedule, except that a minimum number of responses are required in the interval in order to receive reinforcement.
  - Lab example: DRH10"/15 responses = a rat must press a bar 15 times within a 10-second increment to get reinforced.
  - Real world example: "If Lance Armstrong is going to win the Tour de France he has to pedal *x* number of times during the *y*-hour race."
- **Fixed time** (FT) – Provides reinforcement at a fixed time since the last reinforcement, irrespective of whether the subject has responded or not. In other words, it is a non-contingent schedule.
  - Lab example: FT5" = rat gets food every 5 seconds regardless of the behavior.
  - Real world example: a person gets an annuity check every month regardless of behavior between checks
- **Variable time** (VT) – Provides reinforcement at an average variable time since last reinforcement, regardless of whether the subject has responded or not.

5.1.1 Effects of different types of simple schedules

- Fixed ratio: activity slows after reinforcer and then picks up.
- Variable ratio: high rate of responding, greatest activity of all schedules, responding rate is high and stable.
- Fixed interval: activity increases as deadline nears, can cause fast extinction.
- Variable interval: steady activity results, good resistance to extinction.
- Ratio schedules produce higher rates of responding than interval schedules, when the rates of reinforcement are otherwise similar.
- Variable schedules produce higher rates and greater resistance to extinction than most fixed schedules. This is also known as the Partial Reinforcement Extinction Effect (PREE).
- The variable ratio schedule produces both the highest rate of responding and the greatest resistance to extinction (for example, the behavior of gamblers at slot machines).
- Fixed schedules produce "post-reinforcement pauses" (PRP), where responses will briefly cease immediately following reinforcement, though the pause is a function of the upcoming response requirement rather than the prior reinforcement.[23]
  - The PRP of a fixed interval schedule is frequently followed by a "scallop-shaped" accelerating rate of response, while fixed ratio schedules produce a more "angular" response.
    - fixed interval scallop: the pattern of responding that develops with fixed interval reinforcement schedule, performance on a fixed interval reflects subject's accuracy in telling time.

- Organisms whose schedules of reinforcement are "thinned" (that is, requiring more responses or a greater wait before reinforcement) may experience "ratio strain" if thinned too quickly. This produces behavior similar to that seen during extinction.
  - Ratio strain: the disruption of responding that occurs when a fixed ratio response requirement is increased too rapidly.
  - Ratio run: high and steady rate of responding that completes each ratio requirement. Usually higher ratio requirement causes longer post-reinforcement pauses to occur.
- Partial reinforcement schedules are more resistant to extinction than continuous reinforcement schedules.
  - Ratio schedules are more resistant than interval schedules and variable schedules more resistant than fixed ones.
  - Momentary changes in reinforcement value lead to dynamic changes in behavior.[24]

5.2 Compound schedules

Compound schedules combine two or more different simple schedules in some way using the same reinforcer for the same behavior. There are many possibilities; among those most often used are:

- **Alternative schedules** – A type of compound schedule where two or more simple schedules are in effect and whichever schedule is completed first results in reinforcement.[25]
- **Conjunctive schedules** – A complex schedule of reinforcement where two or more simple schedules are in effect independently of each other, and requirements on all of the simple schedules must be met for reinforcement.
- **Multiple schedules** – Two or more schedules alternate over time, with a stimulus indicating which is in force. Reinforcement is delivered if the response requirement is met while a schedule is in effect.
  - Example: FR4 when given a whistle and FI6 when given a bell ring.
- **Mixed schedules** – Either of two, or more, schedules may occur with no stimulus indicating which is in force. Reinforcement is delivered if the response requirement is met while a schedule is in effect.
  - Example: FI6 and then VR3 without any stimulus warning of the change in schedule.
- **Concurrent schedules** – A complex reinforcement procedure in which the participant can choose any one of two or more simple reinforcement schedules that are available simultaneously. Organisms are free to change back and forth between the response alternatives at any time.
  - Real world example: changing channels on a television.
- **Concurrent-chain schedule of reinforcement** – A complex reinforcement procedure in which the participant is permitted to choose during the first link which of several simple reinforcement schedules will be in effect in the second link. Once a choice has been made, the rejected alternatives become unavailable until the start of the next trial.
- **Interlocking schedules** – A single schedule with two components where progress in one component affects progress in the other component. An interlocking FR60–FI120, for example, each response subtracts time from the interval component such that each response is "equal" to removing two seconds from the FI.
- **Chained schedules** – Reinforcement occurs after two or more successive schedules have been completed, with a stimulus indicating when one schedule has been completed and the next has started
  - Example: FR10 in a green light when completed it goes to a yellow light to indicate FR3, after it is completed it goes into red light to indicate VI6, etc. At the end of the chain, a reinforcer is given.
- **Tandem schedules** – Reinforcement occurs when two or more successive schedule requirements have been completed, with no stimulus indicating when a schedule has been completed and the next has started.
  - Example: VR10, after it is completed the schedule is changed without warning to FR10, after that it is changed without warning to FR16, etc. At the end of the series of schedules, a reinforcer is finally given.
- **Higher-order schedules** – completion of one schedule is reinforced according to a second schedule; e.g. in FR2 (FI10 secs), two successive fixed interval schedules require completion before a response is reinforced.

5.3 Superimposed schedules

The psychology term *superimposed schedules of reinforcement* refers to a structure of rewards where two or more simple schedules of reinforcement operate simultaneously. Reinforcers can be positive, negative, or both. An example is a person who comes home after a long

day at work. The behavior of opening the front door is rewarded by a big kiss on the lips by the person's spouse and a rip in the pants from the family dog jumping enthusiastically. Another example of superimposed schedules of reinforcement is a pigeon in an experimental cage pecking at a button. The pecks deliver a hopper of grain every 20th peck, and access to water after every 200 pecks.

Superimposed schedules of reinforcement are a type of compound schedule that evolved from the initial work on simple schedules of reinforcement by B.F. Skinner and his colleagues (Skinner and Ferster, 1957). They demonstrated that reinforcers could be delivered on schedules, and further that organisms behaved differently under different schedules. Rather than a reinforcer, such as food or water, being delivered every time as a consequence of some behavior, a reinforcer could be delivered after more than one instance of the behavior. For example, a pigeon may be required to peck a button switch ten times before food appears. This is a "ratio schedule". Also, a reinforcer could be delivered after an interval of time passed following a target behavior. An example is a rat that is given a food pellet immediately following the first response that occurs after two minutes has elapsed since the last lever press. This is called an "interval schedule".

In addition, ratio schedules can deliver reinforcement following fixed or variable number of behaviors by the individual organism. Likewise, interval schedules can deliver reinforcement following fixed or variable intervals of time following a single response by the organism. Individual behaviors tend to generate response rates that differ based upon how the reinforcement schedule is created. Much subsequent research in many labs examined the effects on behaviors of scheduling reinforcers.

If an organism is offered the opportunity to choose between or among two or more simple schedules of reinforcement at the same time, the reinforcement structure is called a "concurrent schedule of reinforcement". Brechner (1974, 1977) introduced the concept of superimposed schedules of reinforcement in an attempt to create a laboratory analogy of social traps, such as when humans overharvest their fisheries or tear down their rainforests. Brechner created a situation where simple reinforcement schedules were superimposed upon each other. In other words, a single response or group of responses by an organism led to multiple consequences. Concurrent schedules of reinforcement can be thought of as "or" schedules, and superimposed schedules of reinforcement can be thought of as "and" schedules. Brechner and Linder (1981) and Brechner (1987) expanded the concept to describe how superimposed schedules and the social trap analogy could be used to analyze the way energy flows through systems.

Superimposed schedules of reinforcement have many real-world applications in addition to generating social traps. Many different human individual and social situations can be created by superimposing simple reinforcement schedules. For example, a human being could have simultaneous tobacco and alcohol addictions. Even more complex situations can be created or simulated by superimposing two or more concurrent schedules. For example, a high school senior could have a choice between going to Stanford University or UCLA, and at the same time have the choice of going into the Army or the Air Force, and simultaneously the choice of taking a job with an internet company or a job with a software company. That is a reinforcement structure of three superimposed concurrent schedules of reinforcement.

Superimposed schedules of reinforcement can create the three classic conflict situations (approach–approach conflict, approach–avoidance conflict, and avoidance–avoidance conflict) described by Kurt Lewin (1935) and can operationalize other Lewinian situations analyzed by his force field analysis. Other examples of the use of superimposed schedules of reinforcement as an analytical tool are its application to the contingencies of rent control (Brechner, 2003) and problem of toxic waste dumping in the Los Angeles County storm drain system (Brechner, 2010).

5.4 Concurrent schedules

In operant conditioning, concurrent schedules of reinforcement are schedules of reinforcement that are simultaneously available to an animal subject or human participant, so that the subject or participant can respond on either schedule. For example, in a two-alternative forced choice task, a pigeon in a Skinner box is faced with two pecking keys; pecking responses can be made on either, and food reinforcement might follow a peck on either. The schedules of reinforcement arranged for pecks on the two keys can be different. They may be independent, or they may be linked so that behavior on one key affects the likelihood of reinforcement on the other.

It is not necessary for responses on the two schedules to be physically distinct. In an alternate way of arranging concurrent schedules, introduced by Findley in 1958, both schedules are arranged on a single key or other response device, and the subject can respond on a second key to change between the schedules. In such a "Findley concurrent" procedure, a stimulus (e.g., the color of the main key) signals which schedule is in effect.

Concurrent schedules often induce rapid alternation between the keys. To prevent this, a "changeover delay" is commonly introduced: each schedule is inactivated for a brief period after the subject switches to it.

When both the concurrent schedules are variable intervals, a quantitative relationship known as the matching law is found between relative response rates in the two schedules and the relative reinforcement rates they deliver; this was first observed by R.J. Herrnstein in 1961. Matching law is a rule for instrumental behavior which states that the relative rate of responding on a particu-

lar response alternative equals the relative rate of reinforcement for that response (rate of behavior = rate of reinforcement). Animals and humans have a tendency to prefer choice in schedules.[26]

6 Shaping

Main article: Shaping (psychology)

Shaping is reinforcement of successive approximations to a desired instrumental response. In training a rat to press a lever, for example, simply turning toward the lever is reinforced at first. Then, only turning and stepping toward it is reinforced. The outcomes of one set of behaviours starts the shaping process for the next set of behaviours, and the outcomes of that set prepares the shaping process for the next set, and so on. As training progresses, the response reinforced becomes progressively more like the desired behavior; each subsequent behaviour becomes a closer approximation of the final behaviour.[27]

7 Chaining

Main article: Chaining

Chaining involves linking discrete behaviors together in a series, such that each result of each behavior is both the reinforcement (or consequence) for the previous behavior, and the stimuli (or antecedent) for the next behavior. There are many ways to teach chaining, such as forward chaining (starting from the first behavior in the chain), backwards chaining (starting from the last behavior) and total task chaining (in which the entire behavior is taught from beginning to end, rather than as a series of steps). An example is opening a locked door. First the key is inserted, then turned, then the door opened.

Forward chaining would teach the subject first to insert the key. Once that task is mastered, they are told to insert the key, and taught to turn it. Once that task is mastered, they are told to perform the first two, then taught to open the door. Backwards chaining would involve the teacher first inserting and turning the key, and the subject then being taught to open the door. Once that is learned, the teacher inserts the key, and the subject is taught to turn it, then opens the door as the next step. Finally, the subject is taught to insert the key, and they turn and open the door. Once the first step is mastered, the entire task has been taught. Total task chaining would involve teaching the entire task as a single series, prompting through all steps. Prompts are faded (reduced) at each step as they are mastered.

8 Persuasive communication & the reinforcement theory

Persuasive communication Persuasion influences any person the way they think, act and feel. Persuasive skill tells about how people understand the concern, position and needs of the people. Persuasion can be classified into informal persuasion and formal persuasion.

Informal persuasion This tells about the way in which a person interacts with his/her colleagues and customers. The informal persuasion can be used in team, memos as well as e-mails.

Formal persuasion This type of persuasion is used in writing customer letter, proposal and also for formal presentation to any customer or colleagues.

Process of persuasion Persuasion relates how you influence people with your skills, experience, knowledge, leadership, qualities and team capabilities. Persuasion is an interactive process while getting the work done by others. Here are examples for which you can use persuasion skills in real time. Interview: you can prove your best talents, skills and expertise. Clients: to guide your clients for the achievement of the goals or targets. Memos: to express your ideas and views to coworkers for the improvement in the operations. Resistance identification and positive attitude are the vital roles of persuasion.

Persuasion is a form of human interaction. It takes place when one individual expects some particular response from one or more other individuals and deliberately sets out to secure the response through the use of communication. The communicator must realize that different groups have different values.[28]:24–25

In instrumental learning situations, which involve operant behavior, the persuasive communicator will present his message and then wait for the receiver to make a correct response. As soon as the receiver makes the response, the communicator will attempt to fix the response by some appropriate reward or reinforcement.[29]

In conditional learning situations, where there is respondent behavior, the communicator presents his message so as to elicit the response he wants from the receiver, and the stimulus that originally served to elicit the response then becomes the reinforcing or rewarding element in conditioning.[28]

9 Mathematical models

A lot of work has been done in building a mathematical model of reinforcement. This model is known as

MPR, short for mathematical principles of reinforcement. Killeen and Sitomer are among the key researchers in this field.

10 Criticisms

The standard definition of behavioral reinforcement has been criticized as circular, since it appears to argue that response strength is increased by reinforcement, and defines reinforcement as something that increases response strength (i.e., response strength is increased by things that increase response strength). However, the correct usage[30] of reinforcement is that something is a reinforcer *because* of its effect on behavior, and not the other way around. It becomes circular if one says that a particular stimulus strengthens behavior because it is a reinforcer, and does not explain why a stimulus is producing that effect on the behavior. Other definitions have been proposed, such as F.D. Sheffield's "consummatory behavior contingent on a response", but these are not broadly used in psychology.[31]

10.1 History of the terms

In the 1920s Russian physiologist Ivan Pavlov may have been the first to use the word *reinforcement* with respect to behavior, but (according to Dinsmoor) he used its approximate Russian cognate sparingly, and even then it referred to strengthening an already-learned but weakening response. He did not use it, as it is today, for selecting and strengthening new behaviors. Pavlov's introduction of the word *extinction* (in Russian) approximates today's psychological use.

In popular use, *positive reinforcement* is often used as a synonym for *reward*, with people (not behavior) thus being "reinforced", but this is contrary to the term's consistent technical usage, as it is a dimension of behavior, and not the person, which is strengthened. *Negative reinforcement* is often used by laypeople and even social scientists outside psychology as a synonym for *punishment*. This is contrary to modern technical use, but it was B.F. Skinner who first used it this way in his 1938 book. By 1953, however, he followed others in thus employing the word *punishment*, and he re-cast *negative reinforcement* for the removal of aversive stimuli.

There are some within the field of behavior analysis[32] who have suggested that the terms "positive" and "negative" constitute an unnecessary distinction in discussing reinforcement as it is often unclear whether stimuli are being removed or presented. For example, Iwata poses the question: "...is a change in temperature more accurately characterized by the presentation of cold (heat) or the removal of heat (cold)?"[33]:363 Thus, reinforcement could be conceptualized as a pre-change condition replaced by a post-change condition that reinforces the behavior that followed the change in stimulus conditions.

11 Applications

11.1 Climate of fear

Main article: Climate of fear

Partial or intermittent negative reinforcement can create an effective climate of fear and doubt.[34]

11.2 Nudge theory

Main article: Nudge theory

Nudge theory (or nudge) is a concept in behavioural science, political theory and economics which argues that positive reinforcement and indirect suggestions to try to achieve non-forced compliance can influence the motives, incentives and decision making of groups and individuals, at least as effectively – if not more effectively – than direct instruction, legislation, or enforcement.

12 See also

- Applied behavior analysis
- Behavioral cusp
- Child grooming
- Dog training
- Learned industriousness
- Overjustification effect
- Power and control in abusive relationships
- Psychological manipulation
- Punishment
- Reinforcement learning
- Reward system
- Society for Quantitative Analysis of Behavior
- Traumatic bonding

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15 External links

- An On-Line Positive Reinforcement Tutorial
- Scholarpedia Reinforcement
- scienceofbehavior.com

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