

Schedules of Reinforcement

By [Annabelle G.Y. Lim](#), published July 02, 2020

Key Takeaways: Reinforcement Schedules

- A reinforcement schedule is a rule stating which instances of behavior, if any, will be reinforced.
- Reinforcement schedules can be divided into two broad categories: continuous schedules and partial schedules (also called intermittent schedules).
- In a continuous schedule every instance of a desired behavior is reinforced, whereas partial schedules only reinforce the desired behavior occasionally.
- Partial reinforcement schedules are described as either fixed or variable, and as either interval or ratio.
- Combinations of these four descriptors yield four kinds of partial reinforcement schedules: fixed-ratio, fixed-interval, variable-ratio and variable-interval.

In 1957, a revolutionary book for the field of behavioural science was published: Schedules of Reinforcement by C.B. Ferster and B.F. Skinner.

Ferster and Skinner's work established that how and when behaviours were reinforced carried significant effects on the strength and consistency of those behaviours.

Table of contents

1. Introduction
2. Continuous Reinforcement Schedule
3. Partial Reinforcement Schedules
4. Fixed Interval
5. Variable Interval
6. Fixed Ratio
7. Variable Ratio
8. Response Rates of Different Reinforcement Schedules
9. Extinction Rates of Different Reinforcement Schedules
10. Implications for Behavioural Psychology

Introduction

A schedule of reinforcement is a component of [operant conditioning](#) (also known as instrumental conditioning). It consists of an arrangement to determine when to reinforce behaviour. For example, whether to reinforce in relation to time or number of responses.

KEY CONCEPTS OF OPERANT CONDITIONING

QUICK
FACTS

Operant conditioning occurs when a learner's behavior is followed by a consequence, or reinforcement.

Positive Reinforcement

- Increases the frequency of a behavior when applied
- Example: if you finish your homework early, you get to go to the movies as a reward

Negative Reinforcement

- Increases the frequency of a behavior when removed
- Example: to stop the buzzing sound in your car, you have to roll up the window

Punishment

- Decreases the frequency of a behavior
- Example: your parents take your cell phone away for one day each week to lower your phone bill

Schedules of reinforcement can be divided into two broad categories: continuous reinforcement, which reinforces a response every time, and partial reinforcement, which reinforces a response occasionally.

The type of reinforcement schedule used significantly impacts the response rate and resistance to extinction of the behaviour.

Research into schedules of reinforcement has yielded important implications for the field of behavioural science, including choice behaviour, behavioural pharmacology and behavioural economics.

Continuous Reinforcement

In continuous schedules, reinforcement is provided every single time after the desired behaviour.

Due to the behaviour reinforced every time, the association is easy to make and learning occurs quickly. However, this also means that extinction occurs quickly after reinforcement is no longer provided.

For Example

We can better understand the concept of continuous reinforcement by using candy machines as an example.

Candy machines are examples of continuous reinforcement because every time we put money in (behaviour), we receive candy in return (positive reinforcement).

However, if a candy machine were to fail to provide candy twice in a row, we would likely stop trying to put money in (Myers, 2011).

We have come to expect our behaviour to be reinforced every time it is performed and quickly grow discouraged if it is not.

Partial (Intermittent) Reinforcement Schedules

Unlike continuous schedules, partial schedules only reinforce the desired behaviour occasionally rather than all the time. This leads to slower learning since it is initially more difficult to make the association between behaviour and reinforcement.

However, partial schedules also produce behaviour that is more resistant to extinction. Organisms are tempted to persist in their behaviour in hopes that they will eventually be rewarded.

For instance, slot machines at casinos operate on partial schedules. They provide money (positive reinforcement) after an unpredictable number of plays (behaviour). Hence, slot players are likely to continuously play slots in the hopes that they will gain money the next round (Myers, 2011).

Partial reinforcement schedules occur the most frequently in everyday life, and vary according to the number of responses rewarded (fixed or variable) or the time gap (interval or ratio) between response.

Fixed Schedule

In a fixed schedule the number of responses or amount of time between reinforcements is set and unchanging. The schedule is predictable.

Variable Schedule

In a variable schedule the number of responses or amount of time between reinforcements change randomly. The schedule is unpredictable.

Ratio Schedule

In a ratio schedule reinforcement occurs after a certain number of responses have been emitted.

Interval Schedule

Interval schedules involve reinforcing a behavior after a period of time has passed. Combinations of these four descriptors yield four kinds of partial reinforcement schedules: fixed-ratio, fixed-interval, variable-ratio and variable-interval.

Fixed Interval Schedule

In operant conditioning, a fixed interval schedule is when reinforcement is given to a desired response after specific (predictable) amount of time has passed.

Such a schedule results in a tendency for organisms to increase the frequency of responses closer to the anticipated time of reinforcement. However, immediately after being reinforced, the frequency of responses decreases.

The fluctuation in response rates means that a fixed-interval schedule will produce a scalloped pattern (refer to figure below) rather than steady rates of responding.

For Example

An example of a fixed-interval schedule would be a teacher giving students a weekly quiz every Monday.

Over the weekend, there is suddenly a flurry of studying for the quiz. On Monday, the students take the quiz and are reinforced for studying (positive reinforcement: receive a good grade; negative reinforcement: do not fail the quiz).

For the next few days, they are likely to relax after finishing the stressful experience until the next quiz date draws too near for them to ignore.

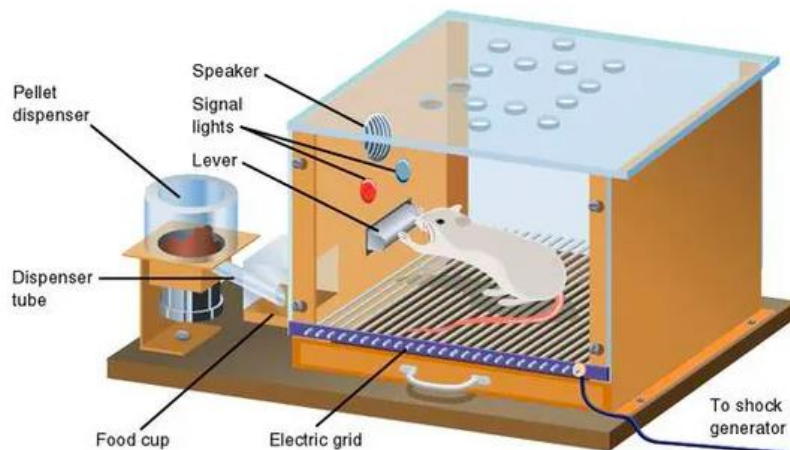
Variable Interval Schedule

In operant conditioning, a variable interval schedule is when the reinforcement is provided after a random (unpredictable) amount of time has passed and following a specific behavior being performed.

This schedule produces a low, steady responding rate since organisms are unaware of the next time they will receive reinforcers.

For Example

A pigeon in Skinner's box has to peck a bar in order to receive a food pellet. It is given a food pellet after varying time intervals ranging from 2-5 minutes.



It is given a pellet after 3 minutes, then 5 minutes, then 2 minutes, etc. It will respond steadily since it does not know when its behavior will be reinforced.

Fixed Ratio Schedule

In operant conditioning, a fixed-ratio schedule reinforces behavior after a specified number of correct responses.

This kind of schedule results in high, steady rates of responding. Organisms are persistent in responding because of the hope that the next response might be one needed to receive reinforcement. This schedule is utilized in lottery games.

For Example

An example of a fixed-ratio schedule would be a dressmaker being paid \$500 after every 10 dresses that they make. After sending off a shipment of 10 dresses, they are reinforced with \$500. They are likely to take a short break immediately after this reinforcement before they begin producing dresses again.

An example of a fixed-ratio schedule would be a dressmaker being paid \$500 10

Variable Ratio Schedule

A variable ratio schedule is a schedule of reinforcement where a behaviour is reinforced after a random number of responses.

This kind of schedule results in high, steady rates of responding. Organisms are persistent in responding because of the hope that the next response might be one needed to receive reinforcement. This schedule is utilized in lottery games.

For Example

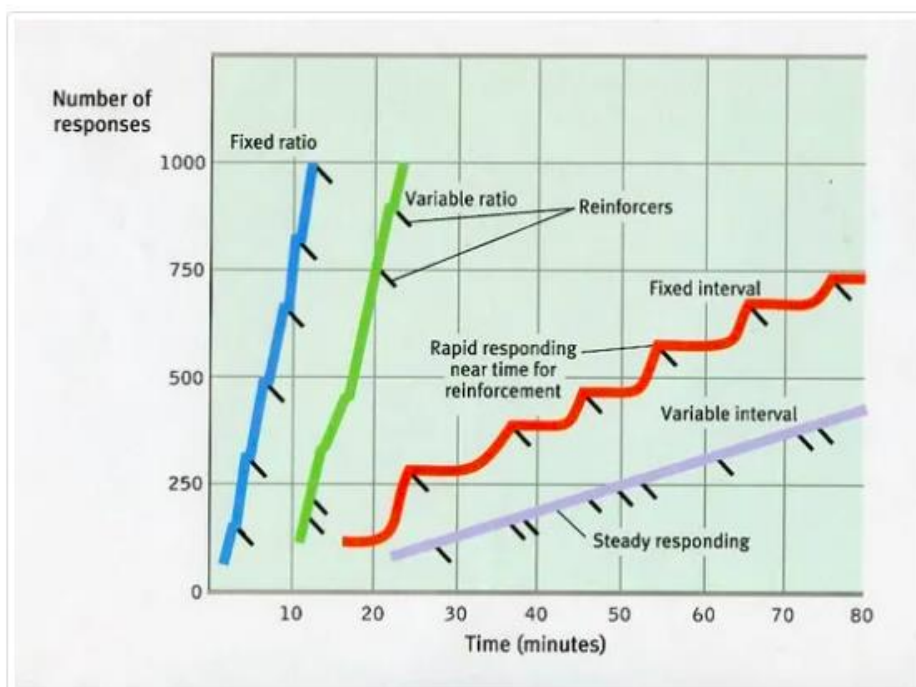
An example of a fixed-ratio schedule would be a child being given a candy for every 3-10 pages of a book they read. For example, they are given a candy after reading 5 pages, then 3 pages, then 7 pages, then 8 pages, etc.

The unpredictable reinforcement motivates them to keep reading, even if they are not immediately reinforced after reading one page.

Response Rates of Different Reinforcement Schedules

Ratio schedules – those linked to number of responses – produce higher response rates compared to interval schedules.

As well, variable schedules produce more consistent behaviour than fixed schedules; unpredictability of reinforcement results in more consistent responses than predictable reinforcement (Myers, 2011).



Extinction of Responses Reinforced at Different Schedules

Resistance to extinction refers to how long a behaviour continues to be displayed even after it is no longer being reinforced. A response high in resistance to extinction will take a longer time to become completely extinct.

Different schedules of reinforcement produce different levels of resistance to extinction. In general, schedules that reinforce unpredictably are more resistant to extinction.

Therefore, the variable-ratio schedule is more resistant to extinction than the fixed-ratio schedule. The variable-interval schedule is more resistant to extinction than the fixed-interval schedule as long as the average intervals are similar.

In the fixed-ratio schedule, resistance to extinction increases as the ratio increases. In the fixed-interval schedule, resistance to extinction increases as the interval lengthens in time.

Out of the four types of partial reinforcement schedules, the variable-ratio is the schedule most resistant to extinction. This can help to explain addiction to gambling.

Even as gamblers may not receive reinforcers after a high number of responses, they remain hopeful that they will be reinforced soon.

Implications for Behavioural Psychology

In his article "Schedules of Reinforcement at 50: A Retroactive Appreciation," Morgan (2010) describes the ways in which schedules of reinforcement are being used to research important areas of behavioural science.

Choice Behaviour

Behaviourists have long been interested in how organisms make choices about behaviour – how they choose between alternatives and reinforcers. They have been able to study behavioural choice through the use of concurrent schedules.

Through operating two separate schedules of reinforcement (often both variable-interval schedules) simultaneously, researchers are able to study how organisms allocate their behaviour to the different options.

An important discovery has been the matching law, which states that an organism's response rates to a certain schedule will closely follow the ratio that reinforcement has been obtained.

For instance, say that Joe's father gave Joe money almost every time Joe asked for it but Joe's mother almost never gave Joe money when he asked for it. Since Joe's response of asking for money is reinforced more often when he asks his father, he is more likely to ask his father rather than his mother for money.

Research has found that individuals will try to choose behaviour that will provide them with the largest reward. There are also further factors that impact an organism's behavioural choice: rate of reinforcement, quality of reinforcement, delay to reinforcement and response effort.

The blog Babble behaviour summarizes the findings well: "Everyone prefers higher amounts, quality, and rates of reward. They prefer rewards that come sooner and requires less overall effort to receive."

Behavioural Pharmacology

Schedules of reinforcement are used to evaluate preference and abuse potential for drugs. One method used in behavioural pharmacological research to do so is through a progressive ratio schedule.

In a progressive ratio schedule, the response requirement is continuously heightened each time after reinforcement is attained. In the case of pharmacology, participants must demonstrate an increasing number of responses in order to attain an injection of a drug (reinforcement).

Under a progressive ratio schedule, a single injection may require up to thousands of responses. Participants are measured for the point where responding eventually stops, which is referred to as the "break point."

Gathering data about the break points of drugs allows for a categorization mirroring the abuse potential of different drugs. Using the progressive ratio schedule to evaluate drug preference and/or choice is now commonplace in behavioural pharmacology.

Behavioural Economics

Operant experiments offer an ideal way to study microeconomic behaviour; participants can be viewed as consumers and reinforcers as commodities.

Through experimenting with different schedules of reinforcement, researchers can alter the availability or price of a commodity and track how response allocation changes as a result.

For example, changing the ratio schedule (increasing or decreasing the number of responses needed to receive the reinforcer) is a way to study elasticity.

Another example of the role reinforcement schedules play is in studying substitutability by making different commodities available at the same price (same schedule of reinforcement). By using the operant laboratory to study behaviour, researchers have the benefit of being able to manipulate independent variables and measure the depending variables.

About the Author

Annabelle Lim is a second-year student majoring in psychology and minoring in educational studies at Harvard College. She is interested in the intersections between psychology and education, as well as psychology and the law.

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How to reference this article:

Lim, A (2020, July 02). *Schedules of reinforcement*. Simply Psychology.
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