

Extinction (operant extinction)

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1. Core Definition

Extinction, within the broader field of behavioral psychology, refers to the systematic process through which a previously learned response or behavior gradually diminishes and ultimately ceases when the conditions that initially maintained it are no longer present. This fundamental principle applies across both classical (respondent) and operant (instrumental) conditioning paradigms, though the specific mechanisms driving the reduction of the response differ significantly between the two. In essence, it represents the weakening of a conditioned association or a reinforced behavior when the consequences that sustained it are withdrawn, leading to the eventual disappearance of the learned reaction.

In the context of **classical conditioning**, extinction occurs when the **conditioned stimulus (CS)** is presented repeatedly without being followed by the **unconditioned stimulus (US)**. Initially, through repeated pairings, the organism learns to associate the CS with the US, leading to a **conditioned response (CR)**. For instance, if a bell (CS) consistently precedes food (US), a dog will learn to salivate (CR) to the sound of the bell alone. If, subsequently, the bell is rung many times without any food appearing, the dog's salivation response to the bell will progressively weaken and eventually cease. This signifies that the learned association between the bell and the food has been effectively "extinguished," although, as discussed later, the original learning may not be completely erased but rather inhibited.

Conversely, in **operant conditioning**, extinction is observed when a behavior that was previously reinforced is no longer followed by any form of reinforcement. An organism performs a behavior (a response) because it has learned that this action leads to a desirable outcome (reinforcement). When this reinforcement is consistently withheld following the behavior, the organism gradually stops performing the behavior. For example, as explicitly noted, if you train your dog to sit on command by consistently giving it a treat or praise (reinforcement) every time it complies, it will reliably sit. However, if you subsequently stop providing any form of reinforcement after the "sit" command, the dog's tendency to sit on command will progressively decrease over time. The behavior will become less frequent and less vigorous until it effectively disappears.

The shared outcome of both classical and operant extinction is the reduction of a specific response. However, the underlying processes are distinct: classical extinction involves the breaking of an S-S (stimulus-stimulus) association, while operant extinction involves the weakening of an R-C (response-consequence) contingency. Understanding these differences is crucial for effective application in various psychological and behavioral contexts, from therapy to animal training, highlighting extinction's role as a cornerstone concept in the study of learning and

adaptive behavior.

2. Etymology and Historical Development

The concept of extinction has its roots deeply embedded in the origins of modern behavioral psychology, emerging from the pioneering experimental work of early 20th-century researchers. The initial observations leading to the formalization of extinction came from the Russian physiologist **Ivan Pavlov**, whose groundbreaking studies on classical conditioning in dogs provided the first empirical evidence of how conditioned reflexes could not only be acquired but also diminished. Pavlov, in his extensive research published in works like *Conditioned Reflexes* (1927) ([Pavlov, 1927](#)), meticulously documented how a conditioned salivation response, once established, would gradually disappear if the conditioned stimulus (e.g., a bell) was presented repeatedly without the subsequent presentation of the unconditioned stimulus (e.g., food). This phenomenon marked the earliest scientific understanding of extinction as a process of reducing learned responses.

Following Pavlov's foundational work, the American psychologist **B.F. Skinner** significantly advanced the understanding of extinction within the framework of **operant conditioning**. In his seminal work, *The Behavior of Organisms: An Experimental Analysis* (1938) ([Skinner, 1938](#)), Skinner detailed how behaviors are shaped and maintained by their consequences (reinforcement). Crucially, he also elaborated on how these operant behaviors could be extinguished by systematically withholding the reinforcement that previously maintained them. Skinner's research, primarily conducted with rats and pigeons in controlled environments (Skinner boxes), demonstrated that without the expected positive consequence, a voluntary behavior would decrease in frequency and intensity, solidifying the concept of operant extinction as a distinct but equally important aspect of learning theory.

The development of extinction as a concept has evolved considerably since these early behaviorist accounts. While initially viewed as a simple "unlearning" or "erasure" of the original association, subsequent research, particularly from a cognitive perspective, has suggested a more complex mechanism. Modern understanding posits that extinction often involves new learning that actively inhibits the original conditioned response, rather than simply deleting it from memory ([Bouton, 2004](#)). This revised view is supported by phenomena like spontaneous recovery and renewal, which indicate that the original learning remains latent and can reappear under certain conditions. Thus, extinction is now understood not merely as the absence of a response, but as an active process of adaptive learning, allowing organisms to update their understanding of environmental contingencies and respond flexibly to changing circumstances, thereby ensuring their behavioral repertoire remains current and efficient.

3. Key Characteristics

Extinction, whether classical or operant, exhibits several predictable and crucial characteristics that shed light on the nature of learning and memory. One of the most prominent features is its **gradual nature**. Extinction is rarely an instantaneous process; rather, the reduction of the learned response typically occurs progressively over a series of trials or presentations of the conditioned stimulus without the unconditioned stimulus, or continued performance of the operant behavior without reinforcement. The speed of extinction can vary depending on factors such as the strength of the original learning, the schedule of reinforcement, and the salience of the stimuli involved. Interestingly, an initial phenomenon known as an **extinction burst** may sometimes occur, where the unreinforced behavior temporarily increases in frequency, intensity, or variability at the onset of extinction before it begins to decline. This brief escalation can be interpreted as the organism's intensified effort to elicit the expected reinforcement when it is initially withheld.

Another critical characteristic of extinction is **spontaneous recovery**. This phenomenon refers to the reappearance of a previously extinguished conditioned response after a period of rest or time away from the extinction context, without any further training or reinforcement. For instance, a dog whose salivation response to a bell has been extinguished might, after a day or two, exhibit a weak but measurable salivation response if the bell is presented again. Spontaneous recovery is typically short-lived and weaker than the original conditioned response, but its occurrence is highly significant. It provides strong evidence that extinction does not erase the original learning but rather suppresses it or involves the learning of a new inhibitory association. The original association between the conditioned stimulus and unconditioned stimulus, or the behavior and its consequence, remains latent and can be reactivated, suggesting that memory for the original learning persists.

The concept of **resistance to extinction** highlights that not all learned behaviors extinguish at the same rate. This resistance refers to how persistent a behavior is in the face of unreinforcement. A key factor influencing resistance to extinction is the **schedule of reinforcement** under which the behavior was originally learned. Behaviors learned under **partial (intermittent) reinforcement schedules** (where reinforcement is not given for every correct response) are generally much more resistant to extinction than behaviors learned under **continuous reinforcement schedules** (where every correct response is reinforced). This is because with partial reinforcement, the organism has learned to expect that reinforcement does not always follow every response, making the absence of reinforcement less immediately noticeable or surprising, and thus leading to greater persistence in the behavior.

Furthermore, extinction can exhibit **context specificity**, often leading to a phenomenon known as the **renewal effect**. This refers to the return of an extinguished response when the organism is returned to the original learning environment (context A) after extinction training has occurred in a

different environment (context B). For example, if a fear response is learned in one room and then extinguished in another, returning to the first room might cause the fear response to reappear, even without the feared stimulus being presented. This context-dependency further supports the idea that extinction is new learning that is specific to the extinction context, rather than a permanent erasure of the original memory. It underscores the brain's sophisticated ability to store multiple, context-dependent associations, allowing for flexible and adaptive behavior in diverse environments (Bouton, 2004). These characteristics collectively illustrate the complexity and adaptive significance of extinction as a fundamental process in behavioral change.

4. Significance and Impact

The concept of extinction holds profound significance across various domains of psychology and has had a substantial impact on both theoretical understanding and practical applications, particularly in the realms of clinical psychology, education, and animal training. Theoretically, extinction provides critical insights into the dynamic nature of learning and memory, demonstrating that learned associations and behaviors are not immutable but are subject to modification and suppression. It underscores the brain's remarkable plasticity and its capacity to adapt to changing environmental contingencies, allowing organisms to discard outdated or no longer functional responses and acquire new, more adaptive ones. This understanding has been instrumental in refining theories of associative learning and has spurred further research into the neural mechanisms underlying the attenuation of conditioned responses, contributing to a more nuanced view of how memory traces are formed, stored, and retrieved.

One of the most impactful applications of extinction is in **therapeutic interventions**. In clinical psychology, techniques derived from classical extinction are central to the treatment of anxiety disorders, phobias, and post-traumatic stress disorder (PTSD). For example, **exposure therapy**, a highly effective treatment for phobias, directly utilizes the principles of classical extinction (Craske et al., 2018). Patients are systematically and repeatedly exposed to the feared object or situation (the CS) in a safe and controlled environment without the occurrence of the feared negative outcome (the US). Over time, the conditioned fear response (CR) gradually extinguishes, as the brain learns that the previously threatening stimulus is no longer associated with danger. Similarly, operant extinction principles are foundational in **Applied Behavior Analysis (ABA)** for reducing maladaptive or undesirable behaviors in individuals, particularly in developmental disorders like autism. By identifying and then systematically withholding the reinforcement that maintains problematic behaviors (e.g., attention for tantrums), therapists can significantly decrease the frequency and intensity of these behaviors, fostering more appropriate forms of communication and conduct.

Beyond clinical settings, extinction principles are widely applied in everyday life, influencing strategies in **education, parenting, and animal training**. In educational contexts, teachers might

use extinction by consistently ignoring disruptive behaviors (provided they are not dangerous) that were previously reinforced by attention, thereby reducing their occurrence. Parents frequently employ extinction when they cease to respond to a child's whining or crying spells that were previously effective in gaining attention or desired items, leading to a decrease in these behaviors over time. In animal training, especially for companion animals or working animals, operant extinction is crucial for correcting undesirable habits. For instance, a dog that consistently jumps on visitors might be trained to stop by having all attention (reinforcement) withheld until all four paws are on the floor, thus extinguishing the jumping behavior.

The significance of extinction also extends to understanding the evolutionary adaptive value of learning. The ability to extinguish outdated responses allows organisms to remain flexible and responsive to dynamic environments, preventing them from wasting energy on behaviors that no longer yield positive outcomes or from reacting fearfully to stimuli that are no longer threatening. This adaptability is critical for survival and successful functioning across species. Consequently, extinction is not merely a laboratory phenomenon but a pervasive and essential mechanism underlying behavioral change, mental health, and the ongoing adaptation of living organisms to their complex surroundings.

5. Debates and Criticisms

Despite its widely accepted status as a fundamental learning process, extinction has been the subject of considerable theoretical debate, primarily concerning the precise nature of the underlying neural and cognitive mechanisms. The most significant debate revolves around whether extinction represents a true "unlearning" or "erasure" of the original conditioned association, or if it constitutes a form of "new learning" that inhibits or suppresses the original response. Early behaviorist views often leaned towards the former, implying that the learned connection was simply broken or weakened to the point of disappearance. However, a wealth of empirical evidence, particularly the phenomena of **spontaneous recovery**, **renewal**, and **reinstatement**, strongly supports the latter perspective (Bouton, 2004). These phenomena demonstrate that the original learning is not permanently deleted but rather remains latent, capable of re-emerging under specific conditions. This suggests that extinction involves the formation of a new inhibitory association (e.g., CS-no US, or Response-no Reinforcement) that competes with and overrides the original excitatory association. The brain learns that in a specific context (the extinction context), the conditioned stimulus or behavior no longer predicts the original outcome.

Methodological considerations and ethical concerns also represent points of discussion regarding extinction procedures. While effective, the process of extinction can sometimes be emotionally distressing or frustrating for the organism, especially during an **extinction burst**, where the unreinforced behavior temporarily intensifies. For instance, in therapeutic applications, exposing an individual to a feared stimulus repeatedly without the expected negative consequence can initially

evoke significant anxiety before relief sets in. Ethical guidelines in both human and animal research and therapy mandate careful consideration of the potential for distress and the implementation of safeguards to manage these challenges. Furthermore, the effectiveness of extinction can be influenced by numerous variables, including the organism's prior learning history, individual differences, the intensity of the original conditioning, and the specific parameters of the extinction procedure, leading to variability in outcomes and necessitating careful, individualized application.

A further criticism or limitation stems from the complexity of real-world behaviors, which rarely operate in isolation. Extinction, in practice, must often account for the interaction of a target behavior with other learning processes and environmental contingencies. For example, while withholding reinforcement might extinguish a specific behavior, other behaviors might emerge to achieve the same outcome (response substitution), or the behavior might be maintained by multiple, sometimes subtle, sources of reinforcement. The concept's generalizability across all forms of learning and across different species also continues to be explored. While universally applicable in broad terms, the precise neural circuits and cognitive factors mediating extinction can vary across species and even across different types of learning within the same species. Therefore, while extinction remains an indispensable concept, its application demands a sophisticated understanding of context, individual differences, and the nuanced interplay of various learning mechanisms to maximize its efficacy and minimize unintended side effects.

6. Further Reading

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