Successive Approximations

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1. Core Definition and Relationship to Shaping

Successive approximations constitute the foundational mechanism of the behavioral procedure known as **shaping**, which is itself a central technique within Operant Conditioning. Simply defined, successive approximations are a series of behaviors that are systematically reinforced because they progress closer and closer to a final, desired, or target behavior that the organism does not spontaneously emit. This technique is employed when the required response is too complex or novel to be taught in a single step, demanding an incremental approach. The success of this method hinges on the trainer's ability to differentially reinforce these increasingly accurate movements while simultaneously extinguishing the previously reinforced, less accurate behaviors. This constant calibration of reinforcement ensures the organism is continuously moving along the behavioral continuum towards the ultimate goal.

The procedure of reinforcing successive approximations effectively bridges the gap between the organism's current behavioral repertoire and the desired complex action. For instance, if the goal is to teach a pigeon to complete a complex sequence of tasks, the probability of the pigeon performing the entire sequence spontaneously is negligible. By breaking the task down into minute, achievable steps--the successive approximations--the trainer utilizes the organism's natural behavioral variability. Each time the organism exhibits a behavior slightly closer to the target than the last reinforced behavior, that new, closer approximation receives positive reinforcement. This systematic reinforcement structure guides the organism's behavior, ensuring that simple, pre-existing responses are transformed into intricate, goal-directed actions through careful environmental manipulation.

2. Theoretical Foundation in Operant Conditioning

The concept of successive approximations is inextricably linked to the work of B.F. Skinner, who formalized the principles of Operant Conditioning. Skinner demonstrated that behaviors are learned and maintained primarily through their consequences. When a consequence is reinforcing, the probability of the preceding behavior recurring increases. Shaping via successive approximations exploits the basic law of effect, utilizing positive reinforcement to mold complex behavior. The necessity for this procedure arises when the target response has a near-zero probability of occurrence. Instead of waiting for the behavior to occur naturally (which might never happen), the environment is structured to facilitate the emergence of sub-components of the target behavior.

A key theoretical underpinning of successive approximations is the concept of **response differentiation**. As reinforcement is applied only to specific behaviors, those behaviors are strengthened, while others are weakened (extinguished). Successive approximations demand that the criterion for reinforcement be continually raised, thus forcing the organism to differentiate between the old, insufficient response and the new, closer response. This process ensures that the organism does not become fixated on an earlier, partial behavior. Furthermore, the effectiveness of successive approximations relies heavily on the principle that organisms naturally exhibit variation in their behavior; this inherent variability provides the raw material necessary for the trainer to select and reinforce behaviors moving in the correct direction.

3. The Mechanism of Differential Reinforcement

The procedural backbone of successive approximations is the rigorous application of **differential reinforcement**. This mechanism involves two simultaneous and interdependent processes: the selective reinforcement of behaviors that match a specified, current criterion, and the non-reinforcement, or extinction, of behaviors that fall short of that criterion. Initially, the criterion is very broad, encompassing almost any behavior that vaguely aligns with the direction of the desired outcome. For example, when teaching a rat to press a lever, the initial approximation might be merely looking at the lever. Once the rat consistently looks at the lever, this behavior is no longer reinforced.

The trainer then immediately shifts the criterion to the next logical step--perhaps taking a single step toward the lever. If the rat reverts to merely looking, the reward is withheld, leading to the rapid extinction of the old behavior and increasing the likelihood that the rat will emit novel variations in its movement. This strategic withholding of reinforcement is crucial; if the trainer continues to reward the less advanced behavior, the rat's progress toward the final goal will stall, a phenomenon often referred to as 'plateauing' in behavioral training. Therefore, the successful implementation of successive approximations requires precise timing and a firm understanding of when to raise the behavioral requirement.

4. Key Characteristics of the Shaping Process

Target Behavior Identification: The process begins with a clear, unambiguous definition of the terminal behavior. Without a specific endpoint, the trainer cannot accurately judge which approximations are moving closer to the goal.
Baseline Behavior Assessment: Understanding the organism's current, natural repertoire helps the trainer select the appropriate starting point for the first approximation.
Small, Incremental Steps: The successive approximations must be carefully chosen to ensure they are small enough to be readily achieved by the organism but large enough to represent meaningful progress. Steps that are too large often lead to frustration or failure, slowing the entire

shaping process.

Immediate and Consistent Reinforcement: Reinforcement must be delivered instantly upon the successful emission of the target approximation. Delays can inadvertently reinforce unrelated behaviors, contaminating the learning process.

Systematic Raising of Criteria: As soon as the organism reliably performs the current approximation, the trainer must cease reinforcing that behavior and only reward the next, closer approximation. This continuous adjustment is the essence of the "successive" nature of the technique.

5. Example Application: Training the Lever Press

A classical laboratory example illustrating successive approximations is the training of a laboratory rat to press a lever within a Skinner Box (operant chamber). Since lever pressing is not an innate behavior for rats in this environment, it must be shaped. The initial goal is defined as the rat applying sufficient downward force on the lever to activate the circuit. The shaping process begins by reinforcing any movement that suggests movement toward the lever.

The first stage involves rewarding the rat simply for being in the half of the cage containing the lever. Once this behavior is stable, the trainer shifts the criterion. Now, the rat is only rewarded if it moves within a few inches of the lever apparatus. The previous behavior (just being on the correct side) is extinguished. In the subsequent stages, the criteria become increasingly refined: the rat must then face the lever, then stand up on its hind legs in the vicinity of the lever, and then, crucially, touch the lever with its paws. At each stage, the behavioral requirement is tightened, ensuring the rat's focus is progressively directed toward the apparatus.

The final, critical approximations focus on the physical interaction required to achieve the goal. After the rat consistently touches the lever, the reward is withheld until it applies actual pressure. Only a light press may be rewarded initially, but the criterion is soon raised until only a full, measurable press that triggers the feeder results in reinforcement. The rat's entire movement repertoire has been molded or "shaped" through the sequence of successive approximations, culminating in the complex, target behavior. The sequence of rewarded actions demonstrates how simple, random movements are systematically transformed into a predictable, goal-directed response through careful control of environmental consequences.

6. Significance and Application Across Disciplines

The significance of successive approximations extends far beyond the controlled environment of the laboratory, serving as a powerful tool in numerous applied behavioral fields. In **clinical psychology** and applied behavior analysis (ABA), shaping is critical for teaching complex self-care skills, communication skills, or academic abilities to individuals with developmental disorders or

cognitive impairments. For instance, teaching a child to tie their shoes or correctly use eating utensils often requires breaking the task down into dozens of approximations, reinforcing each small motor skill achievement sequentially until the entire chain is mastered.

In **education and instruction**, the principle manifests as scaffolding--providing temporary support and guidance that is gradually withdrawn as the learner becomes proficient. Teachers use successive approximations when rewarding initial efforts (e.g., incomplete sentences or rough drafts) before demanding fully polished and complex outputs. Furthermore, in **animal training**, particularly the training of working animals such as police dogs, service animals, or theatrical performers, successive approximations are the primary methodology used to instill highly specific and non-instinctual actions, utilizing positive reinforcement to build complex repertoires from simple components.

7. Criticisms and Methodological Challenges

Despite its effectiveness, the shaping procedure utilizing successive approximations is not without methodological challenges and associated criticisms. One primary difficulty lies in the demand placed upon the trainer. The trainer must maintain constant, vigilant observation and impeccable timing. Failure to administer reinforcement immediately or accurately can lead to the reinforcement of irrelevant behaviors, a phenomenon known as **accidental reinforcement**, which can significantly derail the training process or create unwanted superstitious behaviors in the organism.

Furthermore, shaping is often an exceptionally time-intensive procedure. Generating complex behavior may require hundreds or even thousands of trials across numerous approximations, requiring substantial resources and trainer endurance. A related criticism involves **trainer drift**, where the criteria for reinforcement become inconsistent over time, leading to variability in the subject's performance. Finally, some critics, particularly those from cognitive psychology, argue that while shaping effectively describes how new behaviors are acquired, it fails to account for the internal cognitive processes, insight, or intentionality that may contribute to the speed or manner in which an organism learns new skills.

Further Reading

Operant Conditioning (Wikipedia)
B.F. Skinner (Wikipedia)
Shaping (psychology) (Wikipedia)