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## Superstition Experiment (Staddon and Simmelhag 1971)



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### Synonyms

[Adventitious reinforcement](#); [Spurious correlation](#);  
[Superstitious behavior](#); [Superstitious reinforcement](#)

### Definition of Superstitious Behavior

Vyse (1997) described the difficulty of defining superstitious behavior because it is often a catchall for both the mysterious and mundane activities that we observe in other people. It is often a pejorative term to describe differences between the choices made by the observer and the person being observed. The term, here, refers to a specific situation. How good are nonhumans (and humans) at recognizing a causal relationship between an action and its consequence? Can they be “fooled” into persisting in a behavior even though it does not cause that consequence?

## Skinner (1948) Superstition Experiment

Skinner (1948) reported on the behavior of pigeons that were exposed to a series of presentations of food at regular intervals, irrespective of their behavior (a *fixed time* [FT] schedule; also described as a Pavlovian temporal conditioning procedure). There are many missing methodological details from the article: Missing are number of subjects, number of sessions, exact time intervals, method of identification of responses, temporal contiguity of the different responses to food, and rate changes among those responses. All of those issues are glossed over in a casual presentation in the report. Most descriptions focused on a subset of the results where a FT 15-s schedule was used, with a 5-s food presentation, and a verbal summary is reported.

However, Skinner’s interpretation of the results was vivid and influential. He described a reinforcement effect that was due to *temporal contiguity of response and reinforcer alone*: “. . . conditioning takes place presumably because of the temporal relation only, expressed in terms of the order and proximity of response and reinforcement” (Skinner 1948, p. 168). The reinforcement effect operated on an idiosyncratic range of responses occurring across subjects, including walking counterclockwise, head bobbing, head swinging, and pecking. Skinner concluded that almost any behavior was susceptible to the influence of accidental correlation of a response and a reinforcer. The effect was strong, requiring more

than 10,000 responses before *extinction* (disappearance of the response) in one pigeon. He ended the short article with an extension to human behavior in the description of a bowler wagging at an errant ball, suggesting the power of contiguity of responses and reinforcers to maintain behavior in the absence of a true causal connection. Skinner's interpretation of the effect of spurious connections of response and consequence is termed *adventitious reinforcement* (Sidman 1960) commonly.

### **Staddon and Simmelhag (1971) Reexamination of the Superstition Experiment**

The historical context of the Staddon and Simmelhag (1971) experiment was the occurrence of several puzzling findings in the animal learning literature. Breland and Breland (1961) reported that food-related behavior emerged in animal training and supplanted the reinforced response, even though this new behavior delayed delivery of the reinforcer. For example, a raccoon trained to deposit a token coin for food would spend additional time in the food-related behavior of "washing" the coin instead of depositing the coin to obtain quickly the reward. Williams and Williams (1969) reported that it was very difficult to train a pigeon *not* to peck a lighted disk when it predicted food. Falk (1969) reported that other activities, such as excessive water consumption, would emerge in the post-reinforcement period in a (response-contingent) *variable interval* (VI) or *fixed interval* (FI) food reinforcement schedule when food was not available. The motivation to engage in these activities was strong enough that water could operate as a reinforcer in this period if a response was required to obtain the water. These odd results suggested that Skinner's superstitious behaviors may be controlled by factors other than accidental temporal contiguity of response and reinforcer.

The general design of the Staddon and Simmelhag (1971) experiment is simple. Behaviors are recorded during a (response-independent) FT interval of food presentation for the individual

pigeons. Skinner would predict that whatever response occurred with greatest contiguity to food on initial trials should increase in frequency across trials. The increase should occur as food presentation became more likely. Responses are likely to vary across birds, due to the accidental nature of the original pairing.

The actual method was more complicated. Six pigeons (two with prior experimental experience) were used. The pigeons were exposed to a series of sessions without food in order to develop the set of response categories. Obtained response categories ranged from continuous (R1: head and body oriented toward magazine) to discrete (R7: pecking toward magazine wall) and somewhere in between (R9: preening, any movement in which beak contacts feathers).

Three different reinforcement schedules were used, FI 12-s, FT 12-s, and (*variable time*) VT 8-s. (The FT and VT schedules were defined as response-*independent* FI and VI schedules in the original report.) Reinforcement was 2-s access to mixed grain. Two birds were exposed to all three schedules, two birds were exposed to only the FT and VT schedules, and two birds were exposed to only the FT schedule. The acquisition and *steady-state* (last three sessions) data were analyzed.

### **Results of Staddon and Simmelhag (1971)**

#### **Acquisition Results for Bird 49**

The acquisition results for (experimentally naive) Bird 49 (Fig. 3, Staddon and Simmelhag 1971) encapsulate a major finding of the study. Behavior during the 10- to 12-s portion of the FT interval is of importance because this is the period closest in time to food delivery. Bird 49 spent more than 90% of its time with its head in the food magazine for the first seven sessions during this time period. This result was to be expected because that behavior is contiguous with obtaining food. Abruptly, this response is displaced by pecking on the magazine wall, and pecking became the primary response during this period for the next 29 sessions. Staddon and Simmelhag reported a similar transition with the other five pigeons.

The result was a direct contradiction of the Skinner (1948) contiguity account. The high-frequency response closest in time to food is not maintained. Instead it was replaced abruptly by another response that had not been occurring frequently in prior sessions. The result is reminiscent of the food-related response intrusion effects reported by Breland and Breland (1961).

### Steady-State Behavior

The birds were reported each to settle into a pattern of a small number of responses that occurred in a reliable sequence. The responses were categorized into two classes. *Terminal responses* were activities that occurred consistently before food delivery, typically starting about halfway through the interval. *Interim responses* were activities that began before the terminal response. The classification of an activity as interim or terminal was based on its temporal location during the interval. What could be a terminal response for one bird could be an interim response for another bird. Note the case of Bird 49, cited previously, where pecking began as an interim response and ended as the steady-state terminal response.

### Theoretical Analysis by Staddon and Simmelhag (1971)

The analysis began with the result that the FT food schedule generated a series of different responses (interim and terminal) that occurred in a reliable sequence for individual birds. The results were consistent with findings that show that reinforcement schedules will induce a variety of behaviors beyond the contingent or terminal response. These interim behaviors occur when reinforcement probability was low and have included polydipsia (excessive drinking), pica (eating nonfood material), and wheel-running depending on the activities that were available (Falk 1969). The activities are anomalies according to a traditional Law of Effect because the activities are not contiguous with reinforcement and are not necessary for reinforcement. They had been explained previously as a result of adventitious reinforcement, the spurious correlation between responses and

reinforcement. The question was whether to treat these cases as anomalies or to try to include them in a revised approach to the law of effect. Staddon and Simmelhag rejected the treatment of interim behaviors as odd, anomalous behaviors because they can be observed reliably under wide-ranging conditions. Therefore, they assumed that the activities must have functional significance.

Staddon and Simmelhag identified a critical procedural difference between laboratory learning experiments and the tasks faced by an animal in the wild. Laboratory learning experiments focused on one important requirement (e.g., food or water) and measured a single response related to obtaining that requirement. In the wild, animals must contend with a variety of requirements (e.g., not just one requirement but both food *and* water). Animals are faced with the issue of the best *allocation* of activities to satisfy several different requirements. Therefore, there is evolutionary selection pressure to produce a mechanism that will generate *switching* to new activities. An ideal time to switch would be when current access to a requirement is blocked in order to pursue other requirements. This was the evolutionary analysis that was applied to the results with the FT 12-s food schedule.

A pigeon is deprived of food. The deprivation activates a *state*, defined as a motivational condition in which food-related behaviors are generated and those that produce food are likely to be reinforced. The set of food-related behaviors that are generated come from personal history, species history, and situational circumstances. The Law of Effect selects among these several behaviors. The FT schedule provides food to a food-deprived pigeon on a regular temporally defined basis. Behaviors that become terminal activities are food-related behaviors that are selected as food delivery becomes more probable. They are not randomly emitted activities.

Importantly, interim behaviors are generated in a similar fashion. The time after food delivery is a period of low food probability. Low food probability is a period during which evolution-developed mechanisms produce a *switch to other activities* so as to satisfy the other requirements. Therefore, nonfood activities develop during

these time periods of low food probability. These activities are not randomly emitted either. They are state-induced and are related to other concurrent requirements for life. Other activities can be reinforced by other consequences during these periods, such as a rat pressing a lever to produce access to water even though the rat is not water deprived (Falk 1969). The variety of activities that will occur and be reinforced during this food-free period will depend also on the subject's history, species history, and the structure of the situation. Staddon and Simmelhag (1971) noted the close functional similarity among interim behaviors, adjunctive behaviors (Falk 1969), and the displacement activities, observed in European animal behavior studies (McFarland 1966; Tinbergen 1952).

### Legacy of Staddon and Simmelhag (1971)

Several important consequences followed their results. The first was that the results revealed an important flaw in the analysis of Skinner (1948). Temporal contiguity of response and reinforcer did not explain why one response became the terminal response in the situation. Responses that showed good contiguity initially could be replaced by another response with continued experience. A second important result was to argue, against a dominant operant conditioning metaphor at the time, that responses were “emitted” seemingly at random and then trapped into repetition by contiguity with a reinforcer. Instead, both terminal and interim activities were generated in a causal manner that was related to the variety of survival requirements to be met by the subject. A third consequence was that the study pointed out a conceptual issue with many American animal learning studies, and that was the sole focus on a single consequence and the rate of a single response in obtaining that consequence. The results suggested an unexplored issue was the allocation of behavior for an animal when dealing with multiple requirements and multiple responses. Staddon continued to examine this issue (e.g., Staddon 1980).

An established interpretation (like Skinner's emphasis on temporal contiguity of response and reinforcer) is often accompanied by odd exceptions (like Breland and Breland's observation of displacement of the reinforced response). The legacy of Staddon and Simmelhag (1971) was to rearrange the order of central observations and exceptions to reconnect interesting behavioral effects with a Darwinian analysis of the origin and maintenance of behavior.

### Cross-References

- ▶ [Adjunctive Behavior](#)
- ▶ [Displacement Activities](#)
- ▶ [Instinctive Drift](#)
- ▶ [J. E. R. Staddon Biography](#)
- ▶ [Operant Conditioning](#)
- ▶ [Pavlovian Conditioning](#)

### References

- Breland, K., & Breland, M. (1961). The misbehavior of organisms. *American Psychologist*, *16*, 661–664.
- Falk, J. L. (1969). Conditions producing psychogenic polydipsia in animals. *Annals of the New York Academy of Sciences*, *157*, 569–593.
- McFarland, D. J. (1966). On the causal and functional significance of displacement activities. *Zeitschrift für Tierpsychologie*, *23*, 217–235.
- Sidman, M. (1960). *Tactics of scientific research: Evaluating experimental data in psychology*. New York: Basic Books.
- Skinner, B. F. (1948). ‘Superstition’ in the pigeon. *Journal of Experimental Psychology*, *38*, 168–172.
- Staddon, J. E. R. (Ed.). (1980). *Limits to action: The allocation of individual behavior*. New York: Academic.
- Staddon, J. E. R., & Simmelhag, V. L. (1971). The “superstition” experiment: A reexamination of its implications for the principles of adaptive behavior. *Psychological Review*, *78*, 3–43.
- Tinbergen, N. (1952). “Derived” activities: Their causation, biological significance, origin, and emancipation during evolution. *Quarterly Review of Biology*, *27*, 1–32.
- Vyse, S. A. (1997). *Believing in magic: The psychology of superstition*. New York: Oxford University Press.
- Williams, D. R., & Williams, H. (1969). Auto-maintenance in the pigeon: Sustained pecking despite contingent non-reinforcement. *Journal of the Experimental Analysis*, *12*, 511–520.