

# The nonmaintenance of behavior by noncontingent reinforcement

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The discontinuation of reinforcement in extinction has two components: the contingency between the response and its reinforcer is terminated, and reinforcers are no longer delivered. The latter is responsible for some side-effects of extinction. Noncontingent reinforcement terminates the contingency while reinforcers continue to be delivered. Some implications of this difference are considered in the context of introducing a companion experimental article by Katz & Catania that explores extinction, noncontingent reinforcement and delayed reinforcement procedures with and without the concurrent reinforcement of an alternative response. The effects of noncontingent reinforcement are typically transient and the long-term effectiveness of noncontingent reinforcement in maintaining behavior is typically nil and if it ever does occur it is at best weak. Because reinforcer deliveries are not discontinued, noncontingent reinforcement may have advantages over extinction in many applications aimed at reducing behavior that has been maintained by contingent reinforcement.

Key words: noncontingent reinforcement, extinction, response-reinforcer contingency, side effects, adventitious reinforcement, superstition

The effects of reinforcers delivered independently of behavior have been discussed in terms of noncontingent reinforcement, adventitious reinforcement, incidental reinforcement, accidental reinforcement and superstition, among other labels. Some have argued that to speak of noncontingent reinforcers is a non sequitur or perhaps even an oxymoron, because reinforcers are defined by the effects on responding of contingencies between responses and their consequences and there are no such contingencies when reinforcers are delivered independently of responding. But this is a difficulty only if noncontingent reinforcement is used to refer to the outcome of the procedure rather than the procedure itself. The terminology is not particularly ambiguous if it is used to refer only to the response-independent delivery of stimuli known to be effective as reinforcers and not to the effects of that procedure. That is how the term will function here and I will not further address issues of usage.

Figure 1 illustrates the differences between

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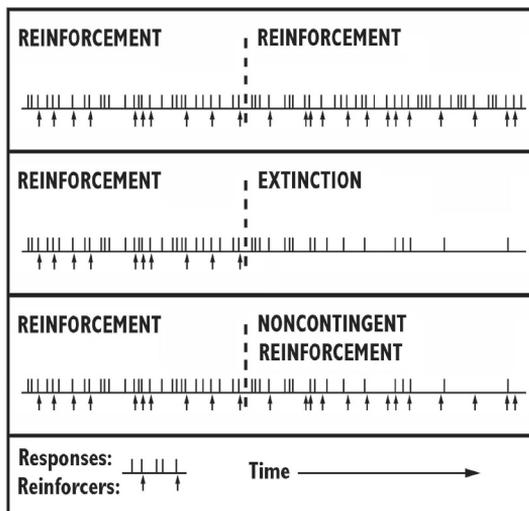


Figure 1. Schematic display of hypothetical responding maintained by intermittent reinforcement and followed at the vertical dashed line by one of three conditions: continuation of the intermittent reinforcement, extinction, or noncontingent reinforcement. With both extinction and noncontingent reinforcement, the discontinuation of the response-reinforcer contingency is followed by a decrease in the rate of responding.

contingent reinforcement, extinction and noncontingent reinforcement. The baseline conditions to the left of the dashed vertical line all show contingent reinforcement. For the purposes of this example, it is assumed to be a rich intermittent schedule, such as a small variable ratio or a short variable interval. The sequence of baseline responses and reinforcers are shown as identical in the three cases. To the right of the dashed line the top frame shows the continuation of intermittent contingent reinforcement, the middle frame shows extinction, and the bottom frame shows noncontingent reinforcement, with the reinforcers yoked to those delivered in the top frame.

The contingency between responses and reinforcers is terminated in both extinction and noncontingent reinforcement, and unlike the top frame both the middle and bottom frames show responding that decreases as time passes. The top and bottom right frames are alike in that they both include reinforcement, whereas the middle and bottom right frames are alike in that neither includes a response-reinforcer contingency.

For completeness it may be of interest also to consider a case in which reinforcers are discontinued but not the response-reinforcer contingency, but it is not obvious how that should be arranged. One possibility is prefeeding to satiation, so that the food continues to be delivered but is no longer functional as a reinforcer. Under such conditions responding would decrease and the contingent food deliveries would decrease accordingly. Another alternative is to substitute some neutral event such as a light or a sound for the food deliveries. Again responding would be likely to decrease together with deliveries of the contingent stimuli, but such decreases would have to be attributed to the ineffectiveness of the contingent stimuli as reinforcers and not to the ineffectiveness of the response-stimulus contingencies.

Notice that the response decrements in the middle and bottom right frames of Figure 1 are shown as equal, on the assumption that responding depends only on the operation of the response-reinforcer contingency. I will return to this point later, but let us first consider another implication of the difference between the extinction and noncontingent reinforcement conditions,

as illustrated in Figure 2. The frames are identical to those in Figure 1, except that the added emoticons represent an important side-effect: in all other conditions, food-deprived rats who had been eating during baseline (left) continue to eat, but in extinction they no longer do so. The discontinuation of these food presentations has behavioral effects sometimes described as emotional (Azrin, Hutchinson, & Hake, 1966; Azrin, Hutchinson, & McLaughlin, 1965; Mowrer & Jones, 1943). For example, during extinction after food reinforcement a rat may urinate and defecate and if appropriate contingencies are arranged the opportunity to attack another organism may function as a reinforcer for some arbitrary response (e.g., during extinction of lever pressing, access to an attack target may reinforce chain pulls).

The significance of this difference between extinction and noncontingent reinforcement became especially clear to me when I began to work on the fourth edition of my text, "Learning" (Catania, 1998). Based on evidence from the classroom that students often fail to see data from nonhuman research as relevant to human behavior, and especially as encouraged by my

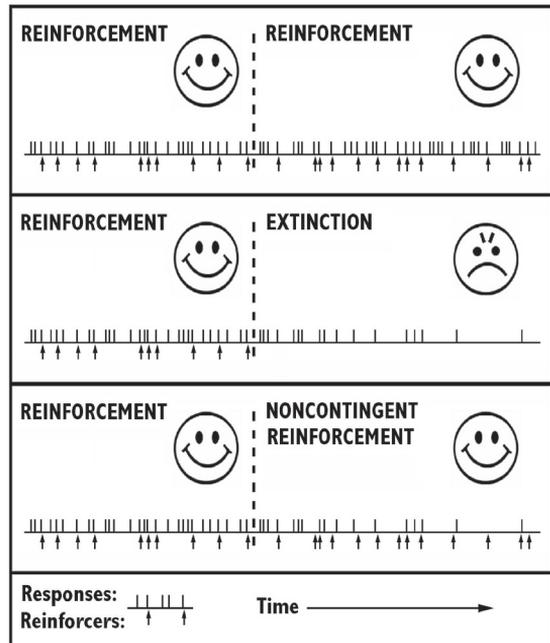


Figure 2. Same as Figure 1, with the addition of emoticons (emotion icons) to represent the different side effects of the various contingencies.

colleague, Eliot Shimoff, I decided to seek out human data on extinction to include as an illustration in the appropriate chapter. In an extensive search of the *Journal of Applied Behavior Analysis*, I was unable to find any human extinction data that appeared suitable for use as a textbook example. When I consulted applied colleagues at the Kennedy Krieger Institute (Catania, DeLeon, & Cataldo, 2001), it became clear that extinction was out of favor in comparison to procedures such as noncontingent reinforcement and the differential reinforcement of other behavior. It was challenging enough to deal with the problem behavior presented by children with severe developmental disabilities; there was no reason to have to deal also with the aggressive behavior or other emotional side-effects of extinction, especially when other techniques had long been available (e.g., Repp & Deitz, 1974; Skiba, Pettigrew, & Alden, 1971).

After all, reinforcers are important. If attention has contributed to the development of the self-injurious behavior of a developmentally delayed child, that tells us how important attention is to the child, who will be better served if we shape more functional alternative ways of commanding attention than if we simply remove attention. The primary message that generations of students seem to have taken away from treatments of behavioral methods in introductory textbooks is that if you see a child engaging in some behavior that you do not approve of you should not reinforce that behavior. But the alternative message is a difficult one. To recommend noncontingent reinforcement coupled with the shaping of alternative behavior to parents and other caregivers poses problems of both communication and implementation. Some textbooks, of course, offer the constructive message that you should catch the child being good (we may lament that the line does not instead suggest catching the child behaving well, but we should not constrain the lay vocabulary with too many of our technical concerns).

The effects on responding of noncontingent reinforcers have long been a behavior analytic concern. Skinner (1948) called particular attention to the issue in his classic article on superstition in the pigeon. In Skinner's experiment, food

was presented to a food-deprived pigeon roughly every 10 or 15 seconds. Skinner noted that when food was delivered just as the pigeon was emitting some response the response was likely to be repeated so that it was again closely followed by a reinforcer delivery; he wrote of the pigeon behaving as if its behavior and the food delivery were causally related.

Subsequent accounts by both Skinner and others emphasized the maintenance of responding by accidental contiguities, but it may be more important that he also noted gradual changes in behavior as the procedure continued. He called these changes topographical drift, but they are also evidence that with regard to any particular response class the effects of adventitious contingencies are transient. It is not inconsistent with this transience that some responses may be observed more often than others during noncontingent reinforcement. In pigeons, for example, pecking, a response occasioned by food, may come to precede food deliveries more often than other responses unrelated to eating (e.g., Brown & Jenkins, 1968; Staddon & Simmelhag, 1971). Although pecking is maintained in such contexts, its source, variously described in terms of elicitation, fixed action patterns, respondents and adjunctive processes (e.g., Catania, 1998, Chapter 4, section B), is in the repeated presentation of stimuli and not in a reinforcement contingency.

The long recognized transience of adventitious effects argues for the limited character of such effects rather than for their ubiquity. The evidence that behavior can be maintained by noncontingent reinforcers is at best weak and saying that it does not have substantial and long-lasting effects in the maintenance of responding by reinforcers is a far more defensible generalization than saying that it does. The analysis of behavior maintained by reinforcement schedules (Ferster & Skinner, 1957) has examined both steady-state behavior, when performance has become fairly stable after extended exposure to a given set of contingencies, and the nature of the transitions that occur in changes from one set of contingencies to another. The transition from reinforcement to extinction and from contingent to noncontingent reinforcement are simply two examples, and questions about the relative rapidity

of these transitions are different from those about whether behavior during extinction or during noncontingent reinforcement is maintained in the steady-state.

These issues are primarily empirical, and the article by Catania & Katz that follows is an experimental contribution to the literature that bears on them. It is based on pigeon research that was conducted with electromechanical equipment roughly twenty-five years ago. Among other factors, one major reason we did not complete it sooner was that we did not know how to deal with some quantitative aspects of the data. In particular, we had no rationale for discussing the logarithmic functions that seemed the best fits to our data. Why should we treat the independent variable, time in sessions, as logarithmically scaled when the dependent variable, response rate, another temporally defined measure, is treated linearly? That issue is addressed in the article that follows so I will not treat it further here, but for a more detailed account see Catania (2005).

With regard to deferring the completion of the manuscript, it is probably also relevant that the argument against long-lasting effects of noncontingent reinforcers seemed less plausible at the time the research was conducted, perhaps in part because of the prevalence of the superstition label and perhaps also because differences between the effects of noncontingent and contingent reinforcement take a long time to emerge if reinforcement rates are high (e.g., the VI and VT 10-s schedules of Catania & Keller, 1981). Yet the literature has not offered substantial support for long-term maintenance of responding by noncontingent reinforcement in either experimental or applied settings (e.g., Boakes, 1973; e.g., Hart, Reynolds, Baer, Brawley, & Harris, 1968). Instead, comparisons have typically been concerned with the observation that responding often declines more slowly with noncontingent reinforcement than with extinction, especially on the first as opposed to later exposures to transitions from one set of contingencies to another (e.g., Catania & Keller, 1981).

Despite what I had learned about the use of extinction and noncontingent reinforcers and related procedures in applied settings, when I wrote the corresponding section of my text

I included the following about the effects of noncontingent reinforcement: "Lever pressing declines slowly because the frequent incidental succession of responses and reinforcers counteracts the effects of terminating the reinforcement contingency.... For this reason, arranging a transition from a reinforcement contingency to response-independent reinforcer deliveries may be a poor way to examine the effects of terminating reinforcement contingencies" (Catania, 1998, p. 76). But I should have known at the time that the passage was inappropriate.

Why has extinction remained the primary way to study the effects of terminating contingencies for so long? Disconnecting the connection between lever and feeder is more convenient than disconnecting the lever while adding a device that occasionally operates the feeder independently of presses, but the answer probably lies elsewhere than in a change in apparatus. It is plausible that accidental contiguities of responses and noncontingent reinforcers will have effects similar to those of scheduled contiguities when reinforcers are contingent upon responding. The organism contacts only the temporal relations between responses and reinforcers and not the contingencies that generated them, so it is not obvious that organisms might be sensitive to the differences in the temporal distributions of response-reinforcer intervals (sometimes subtle) that are necessarily produced by contingent and noncontingent procedures. It is even less obvious that they may be sensitive to differences in various possible mixes of the two sorts of procedures (e.g., Lattal, 1974). Yet they are, as shown for example in Catania & Keller (1981) and in the Katz & Catania article that follows this one.

If some noncontingent reinforcers do have effects on behavior similar to contingent ones early in the transition to noncontingent reinforcement, then responding will decrease more slowly than extinction. This is a concern, but not one large enough to rule out noncontingent reinforcement from consideration in either experimental or applied settings. If higher or lower rates of noncontingent reinforcement are available as an option, this concern favors the use of the lower rates. But if behavior persists for long periods of time under such arrangements it might be

more appropriate to look for other sources of the behavior than to attribute the source of behavior to adventitious correlations of responses and reinforcers.

The arguments are reminiscent of those about the hidden costs of reward. The relevant research seemed to show that after children had received gold stars for completing a class activity such as finger painting, when the gold stars were discontinued the activity temporarily decreased relative to that in a control group that had not received gold stars. The effect, when demonstrable at all, is typically small and transient (Cameron, Banko, & Pierce, 2001). Nevertheless, it has been the basis for recommendations against the use of reinforcers in the classroom (Kohn, 1993). Behavior during transitions from one set of contingencies to another depends on the starting as well as the ending conditions, and it is therefore crucial to distinguish questions about the nature of behavior during the transitions from those about the maintenance of behavior in steady-state.

If noncontingent reinforcers have no intrinsic maintaining effect on responses but only transient ones, then perhaps other procedures should also be reconsidered. For example, in the differential reinforcement of other behavior (DRO) the contingency is based upon the absence of some targeted response, and once that response drops to very low rates the delivery of reinforcers is noncontingent relative to all others. Given that increases in the other behavior are inversely correlated with decreases in the targeted response and given that the DRO contingency becomes more like noncontingent reinforcement as the rate of the target response approaches zero, is it appropriate under such circumstances to speak of those other responses as having been reinforced? Although it does not include DRO contingencies, the Katz & Catania paper that follows is relevant because the "other behavior" is more explicitly measurable as pecks on a second key.

In any case, the time is long past to acknowledge fully the transient effects of noncontingent reinforcement in the maintenance of behavior. The case has been made above that it is typically preferable to extinction in applied settings. But given that it involves terminating only the response-reinforcer contingency and does not

produce some of the side-effects of extinction, as illustrated in Figure 2, perhaps the time has come to argue that it is not merely another way to study the effects of terminating contingencies but is actually the preferable way to do so.

These arguments apply mainly to extinction after positive reinforcement. Different issues may arise if they are extended to extinction after negative reinforcement. An escape or avoidance contingency may be terminated either by omitting the aversive stimulus or by delivering the aversive stimulus independently of behavior. Given that escape and avoidance responses are reinforced by the removal or omission of the aversive stimulus, the former procedure might be regarded as functionally most analogous to noncontingent reinforcement in the positive case, whereas the latter might be regarded as most analogous to extinction in the positive case because only the response-reinforcer contingency is terminated. Given the ubiquity of aversive events in natural environments (e.g., Perone, 2003), an experimental analysis of the effects of such contingencies is likely to be of considerable interest.

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