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ON THE DIFFERENCE IN RESISTANCE TO EXTINCTION FOLLOWING REGULAR AND PERIODIC REINFORCEMENT[1]

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COMMENT BY AUTHOR

This piece is not "theoretical" although it has often been regarded that way. It treats, first, with the matter of how a response is to be defined, and, second, with the empirical facts that response variability changes lawfully both with the passage of time since reinforcement and with shifting reinforcement schedules. If my argument is pressed to its simple end, it holds only that you will get out in extinction what you reinforced in conditioning. In this sense, what I tried to say here is, I think, still valid. Besides, it still seems to me an enduring truth that it is better for science to seek something real to measure than to loiter over invented entities and processes.

The note reveals its vintage by the version of the problem to which it is addressed, and by the satellite arguments mustered (though none is essential) to support the core idea. Certain forms of the problem of resistance-to-extinction owed their existence to the group experimental designs popular at that time. We are today more aware of "acquisition" and "extinction" as transitional phases between steady behavioral states, and also more wary of attributing to single organisms the same course of such phases when measured by group experimental designs. The aim of this note, however, is congenial with these developments, just as the thrust of its reasoning is away from the absolutistic questions of two decades ago toward a more contemporary analysis of behavior.

So, one might say of this note that, while its problem has passed away, its solution remains. Its reappearance at this time may remind us of the progress we have made. It may perhaps also provide a useful starting point for teaching students a concern for the datum of response variability, and for experimental designs and assumptions.

In the case of conditioned operants like bar-pressing, it is well established that resistance to extinction is greater after some number of periodic (or aperiodic) reinforcements than after an equal number of regular reinforcements. It is possible, I think, to offer an explanation of this difference along the following lines.

We can approach the problem by asking, "*What* is extinguishing after regular reinforcement as compared with after periodic?" The concept of the generic nature of a response leads us to answer that "the response" is extinguishing. The "response" is defined in advance (say, "bar-pressing"); and it is measured in terms of its categorical appearance or non-appearance, without regard to the subgenera or sub-categories of different responses that result in a bar depression. The answer to our problem, however, may require that we take into account the various movements, or responses, or response forms, that make up the genus "bar-pressing"—that is, the sub-categories that make up the generic category.

[1]Reprints may be obtained from the author at the Department of Psychology, Queens College of the City University of New York, Flushing, N.Y. 11367.

It has been shown by Antonitis (Ph.D. dissertation, Columbia, forthcoming[2]) that (a) the variability of response topography in a series of regular reinforcements falls toward an asymptote (greater than zero in his experiment, though it is theoretically possible to assume the asymptote to be zero under certain conceivable conditions); and, (b) the variability of response increases in extinction above the asymptotic level attained during regular or continuous reinforcement. We may interpret those findings as follows. In regular reinforcement, there is a greater probability after each response that the same or a closely similar response will be emitted next time to be reinforced once more. In periodic reinforcement, the extinction following a reinforcement weakens the prior response form until its strength is not greater than that of some other forms or sub-categories; extinction lowers the strength of stronger sub-categories to the level of weaker ones, in this way continually expanding the number or range of equally strong sub-categories from among which one will finally procure the reinforcement. This latter response is probably determined by a large number of variables.

These considerations about the greater variability of response in extinction also suggest an answer to our first question about resistance to extinction after regular and periodic reinforcement schedules. The increased variability in extinction means that more sub-categories of response will be reinforced in periodic schedules which involve extinction periods preceding any reinforcement. We may assume, further, that the strength of each sub-category is a negatively accelerated function of number of reinforcements, with the function approaching an asymptote. This means that a small number of reinforcements for each of many sub-categories can bring about a greater total strength (sum of all sub-category strengths) than a larger number of reinforcements for each of fewer sub-categories. The subsequent extinction of the generic category ("bar-pressing") will then be composed of extinction responses of the enlarged number of response sub-categories ("forms or ways of bar-pressing"), with the result that we get more extinction responses of the gross category "bar-pressing" than after regular reinforcement which creates fewer sub-categories within the gross category. What is extinguishing after regular and periodic schedules? The "response," of course; but it is the generic inclusiveness of the "response" which needs to be examined to explain the greater resistance to extinction following periodic as compared with regular reinforcement.

Some comments arising from the above suggestion may be added here:

1. At the C.E.A.B. meeting last June at Columbia, Skinner presented some data relating to his question, "Why is the extinction curve *curved?*" His feeling was that the fall in response rate was due to a progressive change in stimulus conditions as extinction proceeded; and that the extinction curve could be straightened out if reinforcement were given under varying ("unpredictable to the rat") stimulus conditions, as in periodic schedules, or in aperiodic schedules with intervals varying in arithmetic series or (better still) geometric series. It is true that my own suggestion can be put into logically equivalent statements that depend on stimulus terms rather than response terms, that is, a substitution of "stimulus" (proprioceptive or otherwise) wherever I have used "response." But the converse is also true, and Skinner's notion can be restated in response terms. Thus, the superiority of the geometric series aperiodic schedule may be ascribed to the greater response variability occurring in the longer intervals which are not present in the arithmetic series. Again, the straightening of the extinction curve may be ascribed to the fact that more sub-categories of response have been conditioned by the aperiodic schedule, and that these sub-categories are giving out the earlier (and straighter) portions of their individual extinction curves, with the combined result being a longer straight section of the summed extinction curve. It is for the same reason that a PR cumulative response curve has a straight stage between the initial acceleration stage and the later temporal discrimination scallops. Despite the logical equivalence, I think the present suggestion has at least the merit of standing on a variable that can be measured and experimentally manipulated in a direct way, while the notion of varying stimulus conditions is, so far, entirely presumptive.

[2]Subsequently published as: Antonitis, J. J. Response variability in the white rat during conditioning, extinction, and re-conditioning. *Journal of Experimental Psychology*, 1951, **42**, 273-281.

2. Somewhat similar points to the above may be made with respect to Estes' statistical theory of learning in which samples from a stimulus population that are present at each occurrence of a "response" bear the major, if not the entire, explanatory burden, while "response" is treated in terms of one generic class and occurrences from that class. But if we regard the class as containing sub-classes, occurrences may be distributed among those sub-classes with some degree of independence. It is true that the construct "stimulus sample" may have purely formal properties, and need not be referred to actual stimuli except for conversational or visualization purposes outside the confines of the theory. But even here we might speak statistically of "response" in terms of a sample of elements, r, drawn from a population, R; or, of sampled elements, $s \rightarrow r$, from a population, $S \rightarrow R$. On the formal level, moreover, independent consideration of s and r samples would lead to different, and more complex, equations than those derived from either alone if we grant any degree of independence to the samplings of s and r. Despite the complexity, however, it might be possible this way to avoid multiplying assumptions about s and S in order to handle specific problems like the present one. Finally, thinking in terms of response categories might bring us to experimental hypotheses not so easily generated by stimulus conceptions alone.

3. The problem raised in this Note is different from that of successive conditionings and extinctions which (a) carry each extinction to completion; or, (b) are continued long enough for a discrimination to form. In (a), if extinction is "complete", in that all subcategories of the response are extinguished, reconditioning should produce no greater resistance to extinction than did original conditioning. Periodic schedules increase resistance to extinction only if the intervening extinctions leave some residual strength in the response categories which can be added to by subsequent reinforcement. In (b), the discrimination (either "temporal," or "first non-reinforcement is followed by more non-reinforcement") brings stimulus factors into the picture as controllers of responding in addition to the factor of response sub-category reinforcement. This might be one case where independent treatment of S and R populations by a statistical theory would be desirable.

4. Another of Antonitis's findings is that in the reconditioning session following first (and incomplete) extinction, response variability falls significantly below the apparent variability asymptote of first conditioning. The implications of this result for the present problem are unclear to me.