

THE EXTINCTION OF CHAINED REFLEXES

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The extinction of the conditioned initial member of a chain of reflexes may be brought about by interrupting the chain at any point prior to the unconditioned reflex upon which the conditioning is based. Consider the following example:

$$S^{\text{III}} - R^{\text{III}} \xrightarrow{(A)} S_D^{\text{II}} - R^{\text{II}} \xrightarrow{(B)} S^{\text{I}} - R^{\text{I}}.$$

Let $S^{\text{I}} - R^{\text{I}}$ be a reflex (capable of further analysis) in which the response R^{I} is the seizing, chewing and swallowing of food and in which the stimulus S^{I} is composed of tactual and olfactory stimulation arising from the food. Let R^{II} be the approach to the food tray and S^{II} the stimulation arising from the tray and adjoining parts of the apparatus plus a differentiating component (D) supplied by the sound of a food magazine. Let R^{III} be the pressing downward of a lever and S^{III} the stimulation arising from the lever and adjoining parts of the apparatus. For our present purposes $S^{\text{I}} - R^{\text{I}}$ may be considered an unconditioned reflex. The second link is established as the conditioned reflex $S_0^{\text{II}} - R^{\text{II}}$ by chaining R^{II} to S^{I} .¹ A discrimination between S_D^{II} and S_0^{II} is then established, the response to S_0^{II} being extinguished.² The initial link $S^{\text{III}} - R^{\text{III}}$ is then conditioned by chaining R^{III} to S_D^{II} or, more exactly, to the differentiating member D . Then it is possible to extinguish the reflex in response to the lever ($S^{\text{III}} - R^{\text{III}}$) by breaking the chain either at the juncture $R^{\text{III}} \rightarrow S_D^{\text{II}}$ (A) or at $R^{\text{II}} \rightarrow S^{\text{I}}$ (B). We may consider the following cases:

I. Breaking the chain at A we obtain the simple extinction of $S^{\text{III}} - R^{\text{III}}$, since we establish the essential condition by removing the reinforcing stimulus S_D^{II} .³ Our method does not supply information about $S_D^{\text{II}} - R^{\text{II}}$ directly, since it measures only the rate of responding to the lever, but it is clear from inspection that $S_D^{\text{II}} - R^{\text{II}}$ remains fully conditioned. After deep extinction of $S^{\text{III}} - R^{\text{III}}$ the sound of the magazine (completing S_D^{II}) will evoke R^{II} immediately.

II. If we reestablish the connection at A , the first response to S^{III} reconditions the reflex, and if we then break the connection again, we obtain another extinction curve (page 306 in the second reference).

III. If, now, we reconnect at A but break at B , we also get reconditioning of $S^{\text{III}} - R^{\text{III}}$, because the presence of S_D^{II} is an adequate reinforcement, whether or not the later stages of the chain are reinforced (page 427 in reference 5). But as $S_D^{\text{II}} - R^{\text{II}}$ will now be extinguished, it will not continue to reinforce $S^{\text{III}} - R^{\text{III}}$, and the latter reflex will decline in strength.

The extinction of the first member of the chain due to the failure to reinforce the second has been described.³ The effect of reconnection at *A* is shown typically in figure 1*A*. The curve is a record made automatically by a white rat as previously described.³ The first part of the curve shows the extinction of $S^{III} - R^{III}$ when the chain is broken at *A*. A characteristic cyclic deviation is evident. At the arrow the connection at *A* was restored (by connecting the magazine) but that at *B* had been broken (by leaving the magazine empty). It will be seen that the response to the lever is quickly reconditioned, and then goes through a second decline corresponding to the extinction of the reinforcing reflex $S_D^{II} - R^{II}$. More

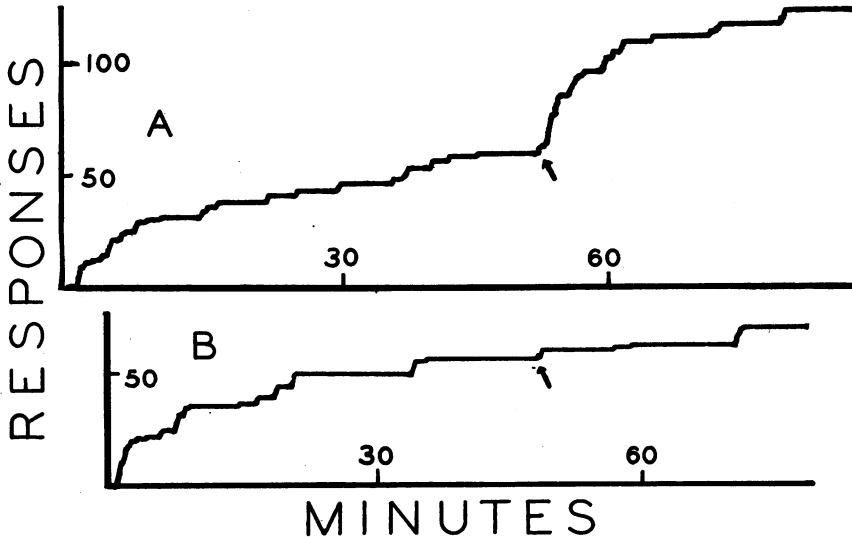


FIGURE 1

A. Extinction curve where the chain is broken at *A* (see diagram in text). At the arrow the chain is reconnected at *A* but broken at *B*. Another extinction curve follows.

B. Extinction curve where the chain is broken at *B*. At the arrow the chain is broken at *A*, but there is no significant effect.

regular curves, of a slightly different shape, may be obtained by using extinction after periodic reconditioning,² examples of which are given in figure 2. The figures *A* and *B* correspond to figure 1*A*. They show the effect of different initial strengths of the reflex, which give different slopes to the curves.

IV. If we break the chain at *B* without having broken at *A*, $S^{III} - R^{III}$ continues to be reinforced by S_D^{II} but declines in strength with $S_D^{II} - R^{II}$ as in Case III. This is shown in the first parts of figures 1*B* and 2*C*.

V. If we reconnect at *B* for one response, a subsequent extinction curve is obtained as in III.³

VI. If we break at *A* after having broken at *B* we get no new extinction curve for $S^{III} - R^{III}$ alone. This is shown typically in figures 1*B* and 2*C*.

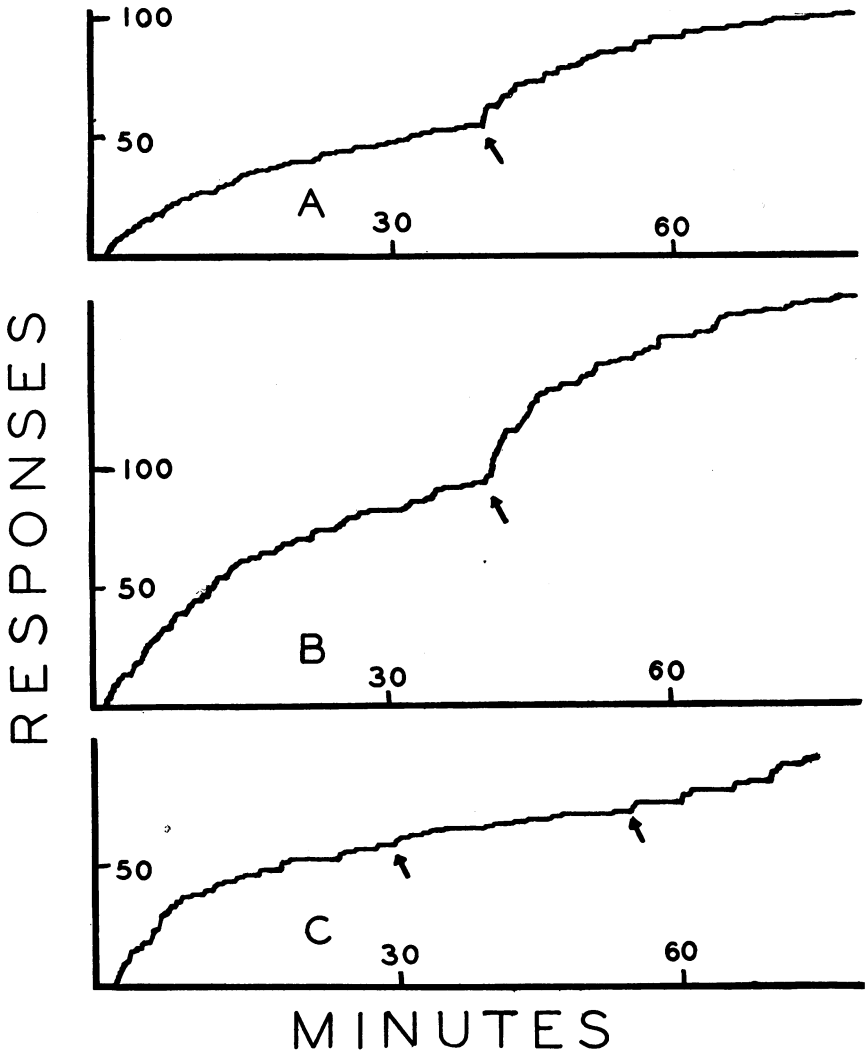


FIGURE 2

Extinction curves after periodic reconditioning.

A and *B*. Chain broken first at *A*; then (at the arrows) at *B*.

C. Chain broken first at *B*; then (at the first arrow) at *A*. At the second arrow the connection at *A* is restored. No significant effect of either change is observed.

The first part of each curve is for extinction at *B*. At the arrow the chain was broken at *A*. The second arrow in figure 2 marks the restoration of the chaining at *A* and shows no significant effect.

We may set up this rule: that the interruption of a chain extinguishes all members up to the point of interruption but not beyond. Since the interruption suppresses the elicitation of all members coming after it, the rule may be stated more significantly as follows: *in a chain of reflexes not ultimately reinforced only the members actually elicited undergo extinction.*

The rule does not state whether the elicited members decline in strength simultaneously or not. We have implied in III that they do not. It is a simpler assumption that the interruption does not have a backward effect upon the whole chain. With the present method it is difficult to show this because we examine only the initial member. It would require many more observations than are now available to settle the point by comparing curves for simple (break at *A*) and remote (break at *B*) extinction, since, as we have seen, there are considerable individual variations in the N_e/N_c ratio,² even when the degree of conditioning has been controlled. (The first curves in figure 1 are approximately of the same area only because we have selected these examples to aid the comparison.) Curves for original extinction are also unfortunately marked by local deviations. It has been pointed out elsewhere on the information then available that there seems to be "no significant difference in the rate or the change of rate" between the two cases.³ Nevertheless it is probable that, in a long chain at least, we could obtain a greater total number of elicitations of the initial member by breaking successively at *A*, *B*, *C*, . . . *N* than by breaking immediately at *N*, and that the curve in the latter case would differ from the curve at *A* in the former.

The question is important. We are justified in regarding a continuous and integrated act of this sort as a chain, not only because the links of which it is composed are put together one by one, but because they may be taken apart at will. But the degree of autonomy of a given part cannot be established until the nature of remote extinction is known.

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¹ "On the Rate of Formation of a Conditioned Reflex," *J. Gen. Psychol.*, **7**, 274,286 (1933).

² "The Rate of Establishment of a Discrimination," *Ibid.*, **9**, 302-350 (1933).

³ "On the Rate of Extinction of a Conditioned Reflex," *Ibid.*, **8**, 114-129 (1933).

⁴ "Drive and Reflex Strength," *Ibid.*, **6**, 22-37 (1932).

⁵ "'Resistance to Extinction' in the Process of Conditioning," *Ibid.*, **9**, 420-429 (1933).